HPV Vaccine Status, Gender, Sexual Identities and Risk Behaviors of Adults Residing in Puerto Rico: A Cross-Sectional Study

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Objective: Currently, in Puerto Rico (PR) there is no study for HPV vaccination rates after implementing mandatory HPV vaccination school-entry policy in 2018. This study aims to (a) explore HPV vaccination status in adults (≥18 years) residing in PR., particularly those who fall within the age range approved for vaccination; (b) describe participants' gender and sexual identities and behavior risk factors; and (c) determine how the willingness to vaccinate against HPV is influenced by sociodemographic factors such as age, gender, education level, and health insurance.

Methods: We conducted a cross-sectional study to understand HPV vaccination status, sexual health and behavior risk factors, and sociodemographic factors in adults residing in PR. Surveys were distributed using various strategies over six months to collect data. Informed consent was obtained, and participants were assured anonymity and data utilization. We performed descriptive and logistic regression analyses using STATA.

Results: From a sample of 314 individuals, 47% were vaccinated, and 82% were familiar with the HPV vaccine. Among the unvaccinated, 49% were open to vaccination. Age and gender significantly predicted vaccination status, with older individuals 65% less likely and females 60% more likely to be vaccinated than males and other genders.

Conclusion: This study identifies age, gender identity, education, and health insurance as pivotal determinants of HPV vaccination status in PR. It also found interest in vaccine information among non-vaccinated people, revealing significant coverage disparities crucial for enhancing vaccination rates and sexual health education.

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Key words: HPV, Vaccination, Sexual behaviors, Sociodemographic factors

Human Papillomavirus (HPV) is the most common sexually transmitted infection (STI) in the United States (US) (1), with nearly 14 million incidences annually (1–3). As of 2018, approximately 80 million Americans were infected (3). In a 2008 study, HPV prevalence in the Latin American and Caribbean community was 2-fold higher than the average worldwide prevalence (4). In 2023, a study conducted in Paraguay revealed that 54.8% of women tested positive for HPV, whereas 42.3% were specifically positive for high-risk HPV types (5). In Puerto Rico (PR), a study in 2018 reported a 79% HPV infection prevalence (6). The Centers for Disease Control and Prevention (CDC) emphasizes that nearly all sexually active individuals will acquire HPV if not vaccinated (7). Over 190 strains of HPV have been identified, each varying in health effects (8,9). As newer-generation sequencing technologies continue to emerge, additional strains are discovered (10). Transmission occurs primarily through sexual contact (11). Vertical transmission, preterm labor, and spontaneous abortions associated to HPV have also been reported (12). In addition, recent animal studies have found the transmission to occur via blood transfusions (13). We summarized several risk factors found in the literature (14) in Figure 1 that contribute to HPV's highly infectious, harmful nature, persistence, and progression. From Figure 1, HPV risk factors are a) sexually related (oral, vaginal, and anal sex, unprotected sex, sexually transmitted diseases (STDs) and multiple sexual partners); b) health-related (limited-medical care, immunosuppressive diseases and STDs); and c) behaviorally related (no HPV vaccination, smoking and use of oral contraceptives).

According to the International Agency for Research on Cancer, HPV types 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, and 59 are associated with cervical cancer (8,10). Strains 6 and 11 cause genital warts in both males and females (13). HPV strains are categorized as low-risk or high-risk, with types 16 and 18 responsible for a significant proportion of anal cancers (90%), adenocarcinomas (85%), cervical squamous cell carcinomas (70%) and other cancers worldwide (8).

In 2015, HPV accounted for 91% of anal and cervical, 70% of oropharynx, and 63% of penile cancers in the US (15). Treatment for HPV-related cancers primarily focuses on managing visible lesions and diseased tissue, as no cure is currently available (8).

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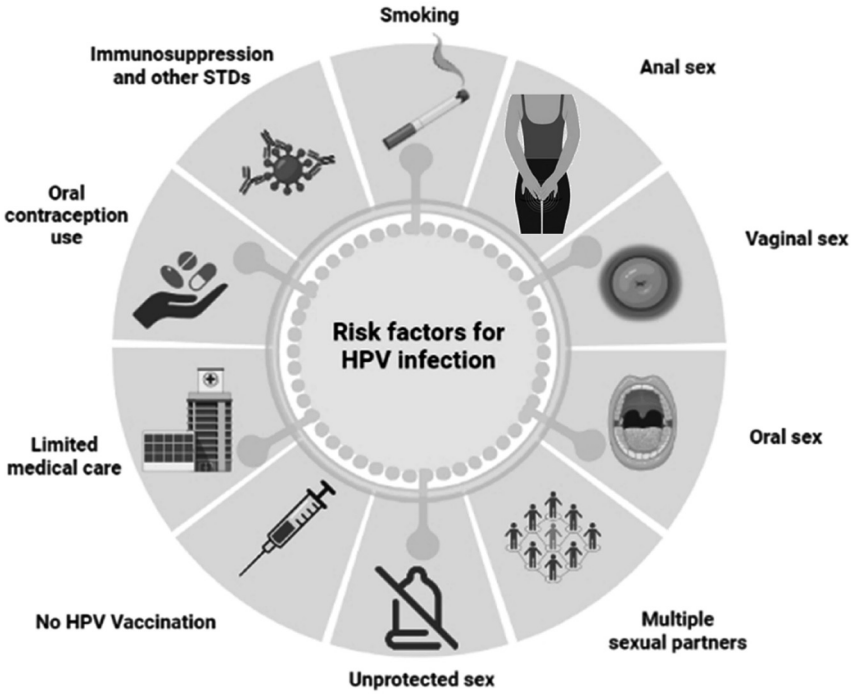
Figure 1. Risk factors for HPV infection, persistence, and progression



Thus, vaccination is the most effective means of prevention, with the 9-valent vaccine recommended since late 2016 (8).

The CDC updated its HPV vaccination recommendations to include all adolescents aged 11-12 through 26, and for certain adults aged 27-45 based on shared decision-making with their healthcare provider, following the Food and Drug Administration's (FDA) expanded vaccine approval for individuals aged 9-45 (1,16). The HPV vaccine has demonstrated efficacy in reducing HPV infection and HPV-related disease incidence when administered in age-appropriate dosing (16). Clinical trials have shown that the vaccine provides an immunogenic response of over 90% in subjects aged 9-26 (16) and 24-45 (17). Despite the proven efficacy and accessibility of HPV vaccines, vaccination rates remain low in the US. Among individuals aged 9-26, for whom the vaccines are covered by insurance, only 69% of females and 63% of males have received the vaccination (15,18,19). In addition to the discrepancies in vaccination status based on gender, race has also been identified as an obstacle to vaccination, with fewer minorities receiving the HPV vaccine (20), including Puerto Rican islanders (21).

According to the Puerto Rican Department of Health, the rates of HPV vaccination in PR are also low (21). As a response, PR, being a territory of the US, implemented mandatory HPV vaccination schedules for teenagers up to 18 attending school to increase vaccination coverage since 2018 (22). While this measure potentially increases vaccination rates among teens, it does not address the population beyond 19, who could also benefit from prophylactic coverage. It is worth noting that PR has been documented to have the highest incidence rate of cervical and penile cancers compared to other states and territories in the US (22).

Given the limited research available on US racial/ethnic minorities, specifically Puerto Ricans, further investigation is needed on this topic. The objectives of our cross-sectional study were three-fold: (a) Explore HPV vaccination status in adults aged 18 and older residing in PR, particularly those who fall within the age range approved for vaccination. (b) Describe participants' risk behaviors and overall sexual health. (c) Examine whether vaccination status and willingness to vaccinate against HPV are influenced by sociodemographic factors such as age, gender, level of education, and health insurance.

Materials and Methods

A cross-sectional study was conducted to understand the risk behaviors, HPV vaccination status, and sociodemographic factors in current PR residents. The inclusion criteria were individuals aged 18 years and older who were residents of PR. Therefore, the exclusion criteria were individuals below 18 years and non-residents of PR. Data was collected via distributing a questionnaire for six months, November 2022-May 2023. Such surveys were distributed through email, social media (Instagram and Facebook), and one health fair. Students from three academic settings in PR assisted in the snowball sampling by sharing the questionnaire's link and QR codes through mass emails.

The survey was conducted in Spanish and was adapted from previous studies conducted in PR (23–25). Our questionnaire can be found in Supporting Information -1. The San Juan Bautista School of Medicine's Institutional Review Board approved the study (EMSJBIRB-9-2022).

There were four questions on sociodemographic factors (age, education, income, and insurance), five questions measuring sexual health and behavior risk factors (gender identity, sexual identity, tobacco use, alcohol consumption, and illicit drug consumption). The survey also included five key questions assessing vaccination status, sources of vaccine information, willingness to receive the vaccine, familiarity with the vaccine, and overall knowledge about the vaccine.

Frequencies were performed as univariate analyses for the categorical variables. Logistic regression was used for bivariate and multivariate analyses to determine the sociodemographic factors that influence HPV vaccination status. Statistical significance was determined at a 95% confidence interval (CI) defined as: *** for $p < 0.001$, * for $p < 0.05$, and non-significant for $p \geq 0.05$. The data analysis was performed using STATA (StataCorp. 2023. Stata Statistical Software: Release 18. College Station, TX: StataCorp LLC).

Participant consent was obtained for this voluntary study, ensuring anonymity and confidentiality by not collecting personal

information. The survey's privacy settings and Google's secure system minimize the risk of data breaches. No significant risks were involved, and participants were free to exit the survey. They were not coerced or given monetary incentives. The potential benefit for participants lies in improving health education and advocacy from their medical team.

Results

The study included 314 participants from a total of 315 survey respondents. One participant was excluded due to not meeting the age requirement. Table 1 presents the demographic characteristics, behavioral risk, and gender/sexual identities. The majority were aged 18-25 (34.39%) or 26-35 (26.43%). Education-wise, 22.93% completed some college, 42.36% held associate/bachelor's degrees. Income-wise, $20,000 - $40,000 group was prominent (21.02%). Insurance coverage was mainly private (73.57%). Behavioral risk-wise, tobacco use was 9.24%, >5 alcoholic drinks consumed by 7.01%, and 5.1% reported illicit drug use. Gender identity included 66.56% female, 32.48% male, and 0.96% other. Sexual identity distribution: heterosexual (85.35%), gay/ bisexual/ pansexual/ asexual (10.83%), preferred not to say (3.82%). This diverse demographic aids a comprehensive exploration of HPV vaccination trends.

Table 2 shows the vaccination status of the study population according to their self-reported data. The percentage of individuals who identified as vaccinated (47%) was similar to those who identified as unvaccinated (53%) against HPV. In addition, 82% of the population indicated they were familiar with the HPV vaccine. The most common source of information about the HPV vaccine among those who disclosed it was health professionals (56%), followed by television or radio (19%) and family and friends (18%). The internet (11%) and newspapers and social magazines (8%) were less frequently used as sources of information on the HPV vaccine.

The data revealed an approximately balanced distribution within the subset of unvaccinated respondents who explicitly disclosed their willingness to consider vaccination upon receiving education. Specifically, 49% had a favorable inclination toward receiving the vaccine series, while the other 51% expressed a lack of interest (18%) or were undecided (33%).

The logistic regression analysis in Table 3 examines the factors of age, education, health insurance, and gender identity as predictors of HPV vaccination status in the studied population of 314 participants living in PR.

Age demonstrated to influence on not being vaccinated against HPV as 65% (Odds ratio (OR): 0.35, $p < 0.001$) were found to be less likely for every unit increase in age while adjusting education, health insurance, and gender identity. Education, on the other hand, was a factor that influenced an 8% (OR: 1.08, p= 0.627) increase in the likelihood of being vaccinated for HPV, adjusting age, health insurance, and gender identity, but it was not statistically significant. Individuals with a private health plan were 21% less likely (OR of 0.79, p= 0.400) to have an HPV vaccine compared with those having a public health plan while adjusting for age, education, and gender identity, yet it was not statistically significant. The variable gender identity was statistically significant indicating that individuals that self -identified as male were 40% (OR: 0.60, p=0.045) less likely to be vaccinated against HPV when compared to other self -identified genders while adjusting age, education, and health insurance. This means that females are the most likely (60%) to be HPV vaccinated. The overall logistical model had a $p < 0.001$ with a R- square of 23%, indicating the HPV vaccination status can be explained by the predictors in the model (not shown).

Table 1. Demographic distribution and health risk factors of participants (n=314)

	Freq.	Percent
Age range		
18-25	108	34.39
26-35	83	26.43
36-45	46	14.65
46-55	46	14.65
56-65	23	7.32
>65	8	2.55
Education		
Completed elementary school	1	0.32
Completed high school	15	4.78
Completed some college courses	72	22.93
Completed an associate or bachelor's degree	133	42.36
Completed a master's or doctorate degree	93	29.62
Income		
Less than $10,000	52	16.56
$10,000 - 20,000	43	13.69
$20,000 - 40,000	66	21.02
$40,000 - 80,000	50	15.92
Greater than $80,000	26	8.28
None	77	24.52
Health insurance		
Public	72	22.93
Private	231	73.57
None	11	3.5
Tobacco use in the last 90 days		
No	285	90.76
Yes	29	9.24
Alcohol consumption in the last 90 days		
None	137	43.63
Yes, <5 drinks in 1 day	155	49.36
Yes, >5 drinks in 1 day	22	7.01
Illicit drug consumption in the last 90 days		
No	298	94.9
Yes	16	5.1
Gender identity		
Female	209	66.56
Male	102	32.48
Bigender	1	0.32
Gender neutral	1	0.32
Gender fluid	1	0.32
Sexual identity		
Heterosexual	268	85.35
Gay/ Bisexual/ Pansexual/ Asexual	34	10.83
Prefer not to say	12	3.82

Table 2. Vaccination status of participants and knowledge of HPV vaccine (n=314)

	Freq.	Percent
Vaccinated against HPV		
No	166	52.87
Yes	148	47.13
HPV vaccine familiarity		
No	57	18.15
Yes	257	81.85
Source of HPV vaccine knowledge		
Health professional		
No	138	43.95
Yes	176	56.05
Family and friends		
No	259	82.48
Yes	55	17.52
Television and radio		
No	255	81.21
Yes	59	18.79
Newspapers and social magazines		
No	290	92.36
Yes	24	7.64
Internet search		
No	279	88.85
Yes	35	11.15
Vaccinated sexual partner		
No	308	98.09
Yes	6	1.91
Unvaccinated sexual partner		
No	312	99.36
Yes	2	0.64
Peered-reviewed scientific articles		
No	289	92.04
Yes	25	7.96
Social Media		
No	292	92.99
Yes	22	7.01
Other source		
No	292	92.99
Yes	22	7.01
Vaccination willingness in the unvaccinated		
No	22	18.03
Yes	60	49.18
Maybe	40	32.79

Discussion

In this study, we examined the factors influencing the willingness to get vaccinated against HPV among adults in PR, shedding light on the sociodemographic factors, sexual identities and risk factors that contribute to vaccine acceptance and highlighting important considerations for public health initiatives aiming to improve HPV vaccination rates in the island.

The socioeconomic construct (age, education, health insurance) and gender identity influence Puerto Ricans in their vaccination status for HPV.

The literature consistently demonstrates that wealth and health are linked to increased health care access and better health outcomes (26). Also, studies have found that low socioeconomic status and risky health behavior increase acute and chronic HPV infections (11, 20). Generally, HPV infection burden has been higher in populations where access to health care has been scarce. In addition, HPV vaccination rates have been shown to be lower in more deprived areas (27, 28).

Table 3. Factors influencing vaccination status in the participants

Vaccinated against HPV	OR	95% CI	*P* value
Age[@]	0.35	0.27 – 0.45	< 0.001***
Education[#]	1.08	0.78 – 1.50	0.627
Health Insurance[$]	0.79	0.46 – 1.36	0.400
Gender Identity[&]	0.60	0.37 – 0.99	0.045*

[@]adjusted for education, health insurance and gender identity
[#]adjusted for age, health insurance and gender identity
[$]adjusted age, education and gender identity
[&]adjusted for age, education, health insurance;
*statistically significant

Table 4. Vaccine status by age group

Age range	% unvaccinated	% vaccinated	Total
18-25	23.15%	76.85%	108
26-35	43.37%	56.63%	83
36-45	80.43%	19.57%	46
46-55	89.13%	10.87%	46
56-65	86.96%	13.04%	23
>65	87.50%	12.50%	8

Table 5. Vaccine status by educational level

Educational level	% unvaccinated	% vaccinated	Total
Completed elementary school	100.00%	0.00%	1
Completed high school	46.67%	53.33%	15
Completed some college courses	43.06%	56.94%	72
Completed an associate's or bachelor degree	51.13%	48.87%	133
Completed a masters or doctorate degree	63.44%	36.56%	93

Interestingly, this study didn't establish a correlation between higher education and higher income. Despite 72% of participants having completed an associate's degree or higher, 51% reported earnings at or below the median annual salary of $21,967 for PR (29). In contrast, 25% reported no income, while 24% earned more than the median. This could be attributed to students with part-time jobs and low minimum wages in PR, because most of our participants are undergraduate and graduate medical students from public and private universities.

In the same way, 74% of the participants had private health insurance, while only 26% reported having Medicaid or being uninsured. This finding contrasts with the expected trend, which suggests that populations with higher poverty levels tend to have higher rates of Medicaid utilization (30). The high number of participants with private insurance coverage can be attributed to the demographics of our study population, which primarily consisted of medical students, undergraduate students from both private and public institutions, and faculty members. Individuals in these groups are more likely to have access to private health insurance through either their families, educational institutions, or employment benefits.

On further examination of vaccination uptake, we observed that 23.15% those aged 18-25, 43.37% aged 26-35, 80.43% aged 36-45 are unvaccinated (Table 4). Similarly, when considering the highest level of education completed, we find that 46.67% of individuals with high school degree, 43.06% with some college courses, 51.13% with an associate's degree, and 63.44% with masters or doctorate degree are unvaccinated (Table 5). These statistics suggest that the expanded age approval for vaccination and higher education levels have not been effective in motivating individuals to pursue prophylactic HPV vaccination, as evidenced by the significant proportion of unvaccinated individuals across age and education groups.

Some of the protective factors observed in this study population were the low prevalence of smoking (9%), heavy alcohol (7%), and illicit drug consumption (5%). Additional protective factors were their familiarity with the HPV vaccine (82%) and their source of vaccine information, with 56 % attributing their knowledge of the vaccine to a health care professional, 19% to television and radio, and 18% to family and friends.

To evaluate an association with HPV vaccine uptake, the authors ran a logistic regression model using age, education, insurance, and gender identity. The study's variance was 23%, which suggests that the variables provided adequate predictive power when determining if individuals have been vaccinated. Furthermore, in examining the odds ratios of the explanatory variables, age and gender identity emerged as significant associations with HPV vaccination status. As age increased, the odds of being vaccinated decreased by 65%. In terms of gender identity, females are 60% more likely to be vaccinated than males and other genders, in agreement with previous studies reported in other countries (31). This finding also confirms why HPV-related cervical pre-cancers have decreased by 40% over the years among vaccinated women (32).

The study findings attribute the observed trends to the historical context of HPV vaccination recommendations in the US and PR, along with the availability of the Vaccine for Children Program (VFC), which offers free vaccination for individuals under 18 (1,3,21,33). While the CDC recommends for teens aged 11-12 through 26, it does not routinely extend the recommendation beyond 27, except for select cases where vaccination from 27-45 is determined beneficial (16,34). However, there is a discrepancy in physician knowledge regarding the expanded FDA-approved vaccination ages of 9-45, and many providers fail to inform eligible patients (35). It is crucial to note that individuals of any age can be exposed to new high-risk HPVs with each new sexual partner (34), necessitating further education for physicians and patients. Medicaid agencies in certain states have approved HPV vaccine coverage for individuals age 9-45 without prior authorization (36). Similarly, graduate students have successfully advocated for coverage with their private insurance companies through social media campaigns (37). These instances emphasize the importance of persistence and education in achieving broader HPV vaccine prophylactic coverage.

Our study has some limitations that should be acknowledged. The data collected on participants' sexual behaviors and vaccination status are based on self-reporting, which may introduce inaccuracies or biases. Additionally, we did not assess whether participants had completed the recommended HPV vaccine series. It is possible that some individuals may have received only one or two doses of the vaccine, which would not provide the full expected efficacy of the vaccine series. Without full completion of the 2- or 3-dose series, the level of protection against HPV may be significantly reduced, potentially affecting the interpretation of vaccination status. Furthermore, we adopted a cross-sectional design, which only provides a snapshot of the participants' characteristics and behaviors at a specific point in time.

In conclusion, this study found that age and gender identity were strong indicators of vaccine status when factors like education and health insurance were considered. Furthermore, a high proportion of non-vaccinated participants showed interest in receiving more information about the vaccine. These insights highlight coverage disparities in HPV vaccination and emphasize sociodemographic factors influencing immunization choices. Such information is crucial for informing public health initiatives aimed at enhancing HPV vaccination rates and fostering sexual health education in PR.

Resumen

Objetivo: En Puerto Rico (PR), no hay estudios sobre las tasas de vacunación contra el VPH tras la política obligatoria de 2018. Este estudio tiene tres objetivos: (a) Explorar el estado de vacunación en adultos (≥18 años); (b) Describir las identidades de género y sexuales de los participantes y los factores de riesgo; y (c) Determinar cómo factores sociodemográficos como edad, género, educación y seguro de salud influyen en la disposición a vacunarse contra el VPH. Métodos: Se realizó un estudio transversal para conocer el estado de vacunación contra el VPH, los factores de riesgo de salud y conducta sexual y los factores sociodemográficos en adultos residentes en PR. Se distribuyeron encuestas utilizando varias estrategias durante seis meses para recopilar datos. Se obtuvo el consentimiento informado y se garantizó el anonimato de los participantes y la utilización de los datos. Se realizaron análisis descriptivos y de regresión logística utilizando STATA. Resultados: De una muestra de 314 individuos, el 47% estaba vacunado y el

82% conocía la vacuna contra el VPH. Entre los no vacunados, el 49% estaba dispuesto a considerar la vacunación. La edad y el género predijeron significativamente el estado de vacunación, con personas mayores un 65% menos propensas y mujeres un 60% más propensas a estar vacunadas que hombres y otros géneros. Conclusión: Este estudio identificó la edad, la identidad de género, la educación y plan de salud como determinantes fundamentales del estado de vacunación contra el VPH en PR. También encontró que existe interés en conocer mas sobre la vacuna entre las personas no vacunadas, revelando disparidades que son cruciales para mejorar las tasas de vacunación y la educación en salud sexual.

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