

Examining Race and Socioeconomic Status as Predictors of Cervical Cancer Screening
and Human Papillomavirus Vaccination in Women

by

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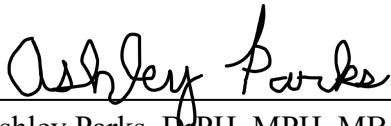
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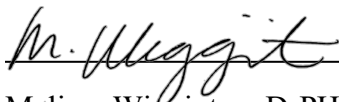
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Abstract

More than 4,000 women die from cervical cancer annually, even though 93% of cervical cancers are preventable with HPV screenings and vaccinations (Centers for Disease Control and Prevention [CDC], 2020). In 2012, women ages 21 to 65 in the United States reported they had not been screened for cervical cancer (CDC, 2020). This study aimed to examine the relationships of between ethnicity/race, income, education, HPV screening, and HPV vaccine uptake of cervical cancer. The 2020 Behavioral Risk Factor Surveillance System (BRFSS) data were used to determine if there was a significant relationship between sociodemographic factors, specifically race, ethnicity, household income, and education, with disparities in HPV screenings and vaccines among women. A cross-sectional research design was utilized. The study revealed a significant relationship between HPV screening across race/ethnicity categories, income level, and education. The findings showed a significant relationship between HPV screening across race/ethnicity categories ($H(5) = 43.846, p < .001$), within income levels ($X^2(1) = 12.077, p < .001$), and for educational attainment ($X^2(1) = 52.220, p < .001$). There also was a significant relationship between HPV vaccination across race/ethnicity categories ($H(5) = 36.367, p < .001$), income level ($X^2(1) = 2.145, p > .143$), and education ($X^2(1) = 14.490, p < .001$). The findings from this study are beneficial in identifying the disparities among women residing in underserved communities for cervical cancer screenings and acquiring the HPV vaccination series. This study demonstrates that race/ethnicity, income, and education may be factors that make a woman more susceptible to cervical cancer. Therefore, health educators must be conscious of a community's cultural background and its impacts when addressing the disparities in HPV vaccine uptake and

cervical cancer screenings. It is vital for public health and healthcare professionals to implement more efforts to promote HPV screening and HPV vaccination at the state and national levels to decrease cervical cancer incidence.

Keywords: HPV screening, HPV vaccination, race, ethnicity, income, education, cervical cancer

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Introduction

Cervical cancer is an overlooked public health concern affecting thousands of Americans annually. Cervical cancer is a disease in which cells abnormally change, develop, and overgrow in the cervix (Centers for Disease Control and Prevention [CDC], 2021). It is the fourth most common cancer diagnosed in women worldwide (World Health Organization [WHO], 2022). Exposure to human papillomavirus (HPV) cancer-causing strains through persistent infections can develop into cervical cancer (Mix et al., 2022). Consequently, women who have never been screened or do not continue their routine screening have a higher risk of developing cervical cancer (Ghebre et al., 2021).

Approximately 13 million Americans are infected with the human papillomavirus (HPV) each year (CDC, 2021). It is recommended that both young men and women receive the HPV vaccine and that women receive regular HPV screenings (CDC, 2021). Primary prevention (HPV vaccination) and secondary prevention (HPV screenings) can reduce the occurrence and severity of cervical cancer cases (WHO, 2022).

Cervical Cancer in the United States

According to the American Cancer Society (2022), approximately 14,100 invasive cervical cancer cases will occur and nearly 4,280 women will pass away from cervical cancer in the United States in 2022. Invasive cervical cancer is initially located on the surface of the cervix to the tissue deeper in the cervix and then the cancer spreads to other organs of the body (National Cancer Institute, 2011). The U.S. Preventive Services Task Force (2018) highly recommends that all women, ages 21 to 29, obtain HPV screenings, such as a Pap smear test, every three years. Women aged 30 to 65 should also get a Pap smear every three years or an HPV test every five years (America's Health Rankings, 2022).

The American Society of Clinical Oncology (ASCO, 2022) reported that the average age of women diagnosed with cervical cancer in the United States is 50 years old. Approximately 20% are diagnosed over the age of 65 because they did not receive regular HPV screenings, such as Pap smears, at an early age (ASCO, 2022). It is uncommon for women younger than 20 to be diagnosed with cervical cancer (ASCO, 2022).

What is Human Papillomavirus (HPV)?

The most common sexually transmitted infection in the United States is HPV (CDC, 2021). The virus enters the body during sexual intercourse by skin-to-skin contact, cuts, or abrasions in the skin (Mayo Clinic, 2021). There are more than 40 HPV strains that can impact men's and women's health in various regions of the body, such as the vulva, linings of the vagina, cervix, skin of the penis, anus, rectum, and the lining of the mouth and throat (CDC, 2021). The Mayo Clinic (2021) states that risk factors for an HPV infection include a high number of sexual partners, skin-to-skin contact with an individual's warts, contact with an exposed surface, weakened immune systems, age, and damaged skin. The symptoms of HPV include genital warts, common warts on hands and fingers, plantar warts on the heels or balls of the feet, and flat warts on the face, beard, or leg regions of the body (Mayo Clinic, 2021). Generally, the human body can combat HPV infections before the appearance of warts depending on the HPV strain (Mayo Clinic, 2021). The HPV strain that is wart-causing is considered "non-oncogenic," and the cancer-causing strain is known as "oncogenic" (CDC, 2021). Approximately 10% of women with an HPV infection on their cervix are at-risk for developing cervical cancer, particularly after having long-lasting HPV infection (CDC, 2021).

Cervical Cancer Caused by HPV

HPV can cause interference in the communication of cells in the body because the virus causes the rapid growth of infected cells, which are identified and regulated by the immune system (National Cancer Institute, 2015). The infected cells continue to multiply until precancerous cells are generated, which can then advance to cancer or the growth of a cancerous tumor (National Cancer Institute, 2015). Cervical cancer arises from the gland cells located in the cervix because of the HPV infection (National Cancer Institute, 2021). The infection can progress into cervical cancer after 20 years or more (Mayo Clinic, 2021). According to Mayo Clinic (2021), HPV infections are the primary cause of cervical cancers. Unfortunately, most HPV infections do not typically have recognizable symptoms (Mayo Clinic, 2021). However, some women may experience pelvic pain or bleeding from the vagina when cervical cancer has progressed (Medline Plus, 2016). Women are at an increased risk of cervical cancer if they have a history of smoking, have several children, consume birth control for a long time, or have an HIV infection (Medline Plus, 2016). Women who have never been screened or do not continue with their routine screening have a higher risk of cervical cancer (Ghebre et al., 2021).

Cervical cancer is the only form of cancer with early detection by implementing preventative measures such as regular screenings and receiving the HPV vaccination series. The other cancers caused by HPV, such as vulva, oropharynx and anal cancer, are frequently diagnosed when other health problems have risen, such as pelvic pain or pain during intercourse and vaginal bleeding after intercourse and in between periods (CDC, 2022). The CDC (2022) reported that cervical cancer was once the leading cause of death for women in the United States. The National Health Interview Survey (NHIS) indicated an alarming decline in screening rates from 2000 to 2018 (MacLaughlin et al., 2022). While cervical cancer incidence and mortality

may have decreased, low socioeconomic status women are still affected because of inadequate access to healthcare resources (MacLaughlin et al., 2022), resulting in a high prevalence of cervical cancer in the United States despite preventive measures.

Race and Socioeconomic Status as Factors that Affect the HPV Screening

The inequalities and barriers women have undergone have contributed to the reduction of screenings and increase in morbidity and mortality rates related to cervical cancer. Women who have never been screened or do not continue with their routine screening have a higher risk of cervical cancer (Ghebre et al., 2021). Disparities in HPV screening are related to sociodemographic factors, including household income, race, and ethnicity (MacLaughlin et al., 2022). Low-income Hispanic and non-Hispanic Black women have a higher risk of cancer and mortality due to the lack of access to HPV testing (Ghebre et al., 2021). Black women are more likely to suffer from cervical cancer and pass away than white women in the United States (Matthews, 2020). In the United States, 60% of cervical cancer cases occur in the South due to the lack of health insurance (Matthews, 2020).

Studies illustrated that approximately 56% of women with cervical cancer were not screened for three years regardless of their access to healthcare (Matthews, 2020). Unfortunately, there has been a decrease in overall screenings, access to screenings, and further guidance and medical care for abnormal screening tests (MacLaughlin et al., 2022). Socioeconomic disadvantages have been linked to women's lower participation in screening and routine visits with their doctor (Amboree et al., 2021). Women who do not engage in regular cervical cancer preventative measures also lack knowledge to practice these preventative measures (Amboree et al., 2021).

How Race and Socioeconomic Status Affect HPV Vaccine Among Women

Racial background and socioeconomic status (SES) have a clear impact on cervical cancer rates despite the availability of preventative measures throughout the U.S. In the United States, non-Hispanic whites demonstrated higher knowledge and awareness of disease risk and healthcare resources than other races/ethnicities, such as Blacks and Hispanics (Lee et al., 2021). Consequently, cervical cancer and HPV infection disparities have continued, including variable vaccination rates across race/ethnicity categories (Hirth, 2019).

Studies implied that Black and Hispanic women are less likely to be insured or have a primary care physician to visit when they are sick or for yearly check-ups (Gelman et al., 2013). This factor prevents a severe barrier to HPV and cervical cancer, given the HPV vaccine is only provided by a doctor or healthcare professional in a clinical setting. Thus, the lack of access to these preventative health services may contribute to the low HPV vaccination rates (Gelman et al., 2013). Inequities in the education of ethnic groups and their awareness regarding HPV vaccines and other HPV preventive health measures (Amboree et al., 2021).

Whether an individual will take the HPV vaccine can be affected by the geographic region in which they live or their race or ethnicity, which may, in turn, impact the health disparities seen in cervical cancer diagnoses. For example, the CDC stated less than half of the adolescent population have completed the HPV vaccine series comprising 53% of Black adolescents and 57% of Hispanic adolescents (as cited by Matthews, 2020). For cervical cancer screenings to be successful. The diversity of the U.S. population assigned females at birth must consider the difficulties associated with their socioeconomic status. Health promotion and education must be implemented within underserved communities to address the disparities in cervical cancer screenings across racial groups and to increase attainment of the HPV

vaccination series. It is crucial that healthcare professionals are educated and promote healthier lifestyle decisions to inhibit this preventable cancer.

Purpose of the Study

Cervical cancer screenings are vital for women's reproductive health. The purpose of this study was to examine the relationship between SES, race/ethnicity, and engaging in preventive measures for cervical cancer. Specifically, the study investigated whether SES and racial/ethnic predictors affected self-reported HPV vaccine uptake and cervical screenings. According to the literature, women who reported a lower SES and women in minority racial/ethnic groups are less likely to obtain cervical cancer screenings. The findings and recommendations from this study will be disseminated to women to encourage preventative measures, such as screenings and health education. Advocating for preventive health behaviors could reduce women's morbidity and mortality associated with cervical cancer.

Research Questions

The following questions were answered in this study:

1. Is there a statistically significant relationship in HPV screening among women across race/ethnicity?
2. Is there an association between income level and HPV screening among women?
3. Is there an association between education level and HPV screening among women?
4. Is there a statistically significant relationship in HPV vaccine among women across race/ethnicity categories?
5. Is there an association between income level and HPV vaccine uptake among women?

6. Is there an association between education level and HPV vaccine uptake among women?

Hypotheses

The first hypothesis was that there would be a statistically significant association between the race/ethnicity and self-reported HPV screening in women. The second hypothesis was that there would be an association between income level and HPV screening among women. The third hypothesis was that there would be an association between education level and HPV screening among women. The fourth hypothesis was that there would be a statistical association between race/ethnicity in self-reported HPV vaccine uptake. The fifth hypothesis was that there would be an association between income levels and HPV vaccination uptake among women. The final hypothesis was that there would be an association between education level and HPV vaccination uptake.

Method

Design

This study utilized a cross-sectional design to investigate the relationship between ethnicity/race, income, education, HPV screening, and HPV vaccine uptake. This research study used secondary data from the 2020 Behavioral Risk Factor Surveillance System (BRFSS). The independent variables were income (SES), educational attainment, and race/ethnicity. The dependent variables were self-reported participation in HPV screening and self-reported HPV vaccine uptake. The BRFSS dataset is directed and supported by the CDC's Population Health Surveillance Branch under the Division of Population Health at the National Center for Chronic Disease Prevention and Health Promotion (CDC, 2021). The BRFSS is a system of continuing health-related telephone surveys used to gather data on health-related risk behaviors, chronic conditions, and the utilization of preventive services from the noninstitutionalized adult population greater or equal to 18 years old living in the United States (CDC, 2021). The BRFSS is a cross-sectional study survey administered by all 50 states and the District of Columbia, Guam, and Puerto Rico (CDC, 2020).

Procedures

Data used in this study were obtained from the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System (BRFSS) 2020 publicly used and de-identified dataset. The BRFSS utilizes both landline telephone and cellular telephone-based surveys. All 50 states, the District of Columbia, Puerto Rico, and Guam collected BRFSS 2020 data. The BRFSS questionnaire is comprised of three parts: (1) the core component, (2) optional BRFSS modules, and (3) the state-added questions (BRFSS, 2021). The core component is a standard set of questions that all contributing states use and include demographics, present

health-related insights, conditions, and behaviors (e.g., health status, alcohol consumption, health-care access, tobacco use, HIV/AIDS risks, and consumption of fruits and vegetables). The core component contains the annual core comprising questions inquired each year and rotating the core questions integrated with even and odd numbered years. The questions for the 23 optional BRFSS modules are specific topics (e.g., prediabetes, diabetes, sugar-sweetened beverages, excess sun exposure, caregiving, shingles, cancer survivorship), which the states can choose to use in their questionnaires. The survey is offered in both English and Spanish.

Participants

Using G*Power Software, version 3.192, with a medium effect size of 0.30, an alpha level of 0.05, and a power of 80%, a minimum sample size of 143 was calculated for the chi-square tests. The 2020 BRFSS public use file contained information for 401,958 individuals, including 218,016 women. A 3% random sample was selected from all participants for a total sample of 6,483 participants. Only 4,521 of those participants provided information related to HPV testing. Only a subsample of female respondents under the age of 49 was eligible to answer the HPV vaccination question, and therefore only 7,198 female respondents completed the HPV vaccination questions. The entire subsample of 7,198 women eligible to complete those questions was utilized in this study.

Independent Variable

In this study, there were three independent variables. The independent variables included race/ethnicity, income (SES), and education. The race/ethnicity variable was used in the first and fourth research questions to assess if there was a significant relationship in HPV screening and HPV vaccination among women. The variable that evaluated race/ethnicity (_IMPRACE) originated from the BRFSS question, "*Imputed race/ethnicity value*," which was a calculated

variable from the BRFSS. The race/ ethnicity categories were Non-Hispanic White, Non-Hispanic Black, Non-Hispanic Asian, Non-Hispanic American Indian/Alaskan Native, Hispanic, and Non-Hispanic Other Race. This variable was not recoded.

The income variable was used in the second and fifth research questions to measure if there was a significant relationship in HPV screening and HPV vaccination among women. Income (INCOME2) was derived from the BRFSS question, "*Is your annual household income from sources: (If respondent refused at any income level, code 'Refused.'"*" This variable was recoded to group into two levels. The first level consisted of the responses: less than \$10,000, less than \$15,000 (\$10,000 to less than \$15,000), less than \$20,000 (\$15,000 to less than \$20,000), and less than \$25,000 (\$20,000 to less than \$25,000). The second level comprised the responses less than \$35,000 (\$25,000 to less than \$35,000), less than \$50,000 (\$35,000 to less than \$50,000), less than \$75,000 (\$50,000 to less than \$75,000), and \$75,000 or more. Additionally, 77 (don't know) and 99 (refused) were collapsed from the data.

The education variable was utilized in the third and sixth research questions to evaluate if there was a significant relationship in HPV screening and HPV vaccination among women. Education (_EDUCAG) developed from the BRFSS question, "*Level of education completed.*" The original levels from the data set included: never attended school or only kindergarten, grades 1 through 8 (elementary), grades 9-11 (some high school), grade 12 or GED (high school graduate), college 1 year to 3 years (some college or technical school), college 4 years or more (college graduate), and refused. This variable was recoded from _EDUCAG to _EDUCAG_RECODE. The four levels consist of did not graduate high school, graduated high school, attended college or technical school, and graduated from college or technical school. Responses of don't know /not sure/missing were removed.

Dependent Variable

Self-reported HPV tests and HPV vaccine uptake were the dependent variables. The question utilized to measure this variable was, *"Have you ever had an HPV test?"* (HPVTEST) (CDC, 2020). The responses implied if the respondent stated whether they had ever had an HPV test. Responses were recorded as 1 = 1 (yes), 2 = 2 (no), 7 = 7 (don't know/not sure), and 9 = 9 (refused). The following question utilized to calculate this variable was, *"Have you ever had an HPV vaccination?"* (HPVADVC4) (CDC, 2021). The original response options from the survey were recorded as 1 = 1 (yes), 2 = 2 (no), 7 = 7 (don't know/not sure), and 9 = 9 (refused). The variable was recorded as "HPVADC4_REC0DE" with invalids removed. The responses indicated whether respondents had ever had an HPV vaccination. Responses were recorded as 1 = 1 (yes) and 2 = 2 (no).

Data Analysis

The IBM® Statistical Package for Social Sciences (SPSS) version 27 was utilized to run an independent samples Kruskal Wallis and chi-square test of independence to determine the relationship between HPV screenings and HPV vaccine uptake and the independent variables. To answer research questions one and four, an independent samples Kruskal Wallis test was used. Research questions two, three, five, and six were answered using the chi-square test of independence.

Results

Participant Demographics

Due to the exploration of research questions addressing HPV vaccination status and HPV screening, different respondents from the 2020 BRFSS dataset were eligible to be included in the data collection for different variables. The study utilized all participants ages 18 to 49 to address research questions 4, 5, and 6 regarding HPV vaccination status. Of those respondents included, the majority were Non-Hispanic White ($N = 4,124$, 57.3%), followed by Non-Hispanic Black ($N = 1,489$, 20.7%). Approximately 28.1% of respondents in the sample had obtained a high school degree or lower ($N = 2,017$), and 71.9% ($N = 5,161$) reported attending some college or above (see Table 1 in Appendix).

For research questions 1, 2, and 3 addressing HPV screening, all female respondents in the BRFSS 2020 sample were eligible. Therefore, this study included a 3% sample of all BRFSS female respondents, including 4,521 valid responses from participants. This random sample was taken separately from the subsample of participants eligible to respond to questions regarding HPV vaccination that was used for research questions 4, 5, and 6; however, there is an overlap between samples. Of those respondents included, the majority were Non-Hispanic White ($N = 3,336$, 73.8%) followed by Non-Hispanic Black ($N = 399$, 8.8%). Approximately 32.1% of respondents in the sample obtained a high school degree or lower ($N = 1,446$), and 67.9% ($N = 3,065$) reported attending some college or above (see Table 2 in Appendix).

Major Findings

This research examined the relationship between ethnicity/race, income (SES), and education on HPV screening and HPV vaccine uptake ages 18 to 49 years old. An independent samples Kruskal Wallis was used to determine if there was a statistically significant relationship

between HPV screening among women across racial/ethnic categories. The findings reveal a significant relationship in self-reported HPV testing across race/ethnicity categories ($H(5) = 43.846, p < .001$). Dunn's test post-hoc analysis was completed to perform pair-wise comparisons and further investigate differences in HPV screening across race ethnicity categories. Non-Hispanic Asian women self-reported a lower screening rate compared to Non-Hispanic Black women ($p = .005$), Hispanic women ($p < .001$), and Other race non-Hispanic women ($p = .001$). Non-Hispanic Asian women reported a screening rate of 32.1% compared to Non-Hispanic Black women (47.4%), Hispanic women (55.1%), and Other race Non-Hispanic women (51.9%). Therefore, women across race ethnicity categories do not have the same self-reported likelihood of seeing a provider for HPV screening (see Table 3 in Appendix).

A chi-square test of independence was used to analyze if there was an association between income level and HPV screening among women to answer research question 2. The results demonstrate a highly significant association in self-reported HPV testing between high- and low-income women ($\chi^2(1) = 12.077, p < .001$). Women with a lower income of less than \$25,000 are 22.7% less likely to visit a healthcare provider to get screened for HPV (OR=.773), compared to women with a higher income of \$25,000 or more (see Table 4 in Appendix).

The third research question was answered using a chi-square test of independence and examined if there was an association between education level and HPV screening among women. A significant association was found ($\chi^2(1) = 52.220, p < .001$). Women with a high school education, or less were 36% less likely to have received an HPV test compared to women with an education of high school graduate and below (OR = .623) (see table 5).

The fourth research question was addressed using the independent samples Kruskal Wallis statistical test to determine if there was a significant relationship in HPV vaccination

among women across race/ethnicity categories. The results show a highly significant association in vaccination across race/ethnicity groups ($H(5) = 36.367, p < .0010$). Dunn's test post-hoc analysis was completed to perform pair-wise comparisons and further investigate associations in HPV vaccination across race ethnicity categories. Non-Hispanic Black women experienced a much lower vaccination rate compared to Non-Hispanic White women ($p = .002$), Hispanic women ($p < .001$), Non-Hispanic Asian women ($p < .001$), and Other race non-Hispanic women ($p < .001$). Black women surveyed report a 21.8% rate of vaccination compared to 25.9% and 29.1% for their White Non-Hispanic and Hispanic counterparts, respectively. Thus, racial/ethnic minority women such as Non-Hispanic Black, Non-Hispanic Asian, and Non-Hispanic American Indian/Alaskan Native are less likely to have had an HPV vaccine (see Table 6 in Appendix).

A chi-square test of independence was used to investigate if there was an association between income level and HPV vaccination uptake among women. The results reveal there is a statistically significant relationship ($\chi^2(1) = 2.145, p < .001$). As a result, a woman's income is associated with attaining the HPV vaccine (see Table 7 in Appendix).

The sixth research question was assessed with the chi-square test of independence to determine if there was an association between education level and HPV vaccine uptake among women. The findings demonstrate a highly significant relationship ($\chi^2(1) = 14.490, p < .001$). Women with a high school education, or below, were 23% less likely to have received an HPV vaccine compared to women with an education of high school graduate and below ($OR = .792$) (see Table 8 in Appendix).

Discussion

Previous research acknowledged the relationships between cervical cancer, HPV screenings, HPV vaccine intake, race/ethnicity, SES, and educational levels (MacLauglin et al., 2022). Additionally, sociodemographic factors, such as race, ethnicity, household income, and education, are associated with disparities in HPV screenings and vaccines (MacLauglin et al., 2022). More research must be conducted to decrease the inequities among women and preventative measures against HPV. Therefore, study focused on cervical cancer screening and HPV vaccine among women, and differences in participation in screening and vaccination across race/ethnicity, income, and educational levels. The research findings revealed six critical outcomes. Although there were study limitations and conflicts, there were statistically significant associations found between the variables in this study, which may have meaningful public health implications.

Summary of Major Findings

There was a significant association in self-reported HPV testing across race/ethnicity categories in this study. The outcomes are consistent with the original hypothesis and with previous studies conducted by Ghebre et al. (2021), and Matthew (2020). Non-Hispanic Black and Hispanic women are at a higher risk of cervical cancer and mortality due to inequalities and barriers that have ultimately decreased HPV screenings in these populations (Ghebre et al., 2021). Unfortunately, in the United States, Black women are more likely to pass away from cervical cancer than white women (Matthews, 2020). However, in the findings Non-Hispanic Asian women had the lowest rate of HPV screenings. Studies have revealed that Asian women have implied the lack of knowledge about cervical cancer and HPV screenings, lack of source of health care, and cultural attitudes towards sexual activity have been components related to the

lower rates of HPV screenings (Gor et al., 2017). In the conservative Asian culture beliefs, HPV screenings correlate to sexual practices, and premarital sexual behavior is not acceptable (Gor et al., 2017). Hence, cervical screenings before marriage would mean personal promiscuity, which is for women who are married or have had children (Gor et al., 2017). Furthermore, the Asian culture belief is that HPV screening reveals troubles that were not a concern (Gor et al., 2017). Consequently, if the healthcare sources are limited, women will not get HPV screenings because it is better not to be aware of the disease.

The study also revealed a significant relationship between income level and HPV screenings among women in the second research question. The discovery is consistent with the original hypothesis and MacLaughlin (2022), who found that woman's income is a component that affects HPV screenings. Low-income women are more than likely to acquire HPV and develop cervical cancer because of the lack of knowledge of and resources to afford preventative measures such as cervical cancer screenings (MacLaughlin et al., 2022). Consequently, socioeconomically disadvantaged women have demonstrated reduced participation in screening and routine visits with their primary care physicians due to the lack of knowledge and/or in financial and health insurance resources (Amboree et al., 2021).

There was also a significant relationship between education level and HPV screening among women in the third research question. The results showed that there was a significant relationship between education level and HPV screening in that those with a high school level education or below were 36% less likely to have received an HPV test compared to women with an education of some college or above. The findings are consistent with the original hypothesis and the study by Rosyda et al. (2018). According to Rosyda et al., 84.6% reported that educational level was positively associated with partaking in cervical cancer screening (2018).

Women with higher academic levels are more likely to participate in cervical cancer preventative health care services such as HPV screenings (Rosyda et al., 2018). Overall, research has shown higher rates of cervical cancer screenings among women with higher educational attainment, which emphasizes the need for health education and health literacy strategies regardless of a women's education level (Rosyda et al., 2018).

There was a statistically significant relationship in HPV vaccination among women across race/ethnicity categories in the fourth research question. These findings are consistent with the original hypothesis and compatible with the studies performed by Hirth (2019) and Amboree et al. (2021), which stated that disparities in HPV vaccination have remained constant across racial/ethnic groups. However, HPV vaccination was highest among Non-Hispanic, White women (25.9%, $p=.002$) and Hispanic women (29.1%) compared to Non-Hispanic, Black women, who experienced a much lower vaccination rate (21.8%). For instance, previous studies have revealed that Black women have a higher medical mistrust and are less likely to participate in preventative health behaviors such as attaining the HPV vaccine (Katz et al., 2016). On the contrary, Hispanic women are more likely to report they have attained the HPV vaccine series. Findings illustrated the vaccine intake was higher in adolescents whose parents' preferred to have the HPV vaccine education delivered in Spanish compared to the parents who received the education in English (Reiter et al., 2020).

There was a significant relationship between income level and HPV vaccination uptake among women in the fifth research question. The results found a significant relationship between income level and HPV vaccination uptake among women, specifically finding that a low income women were 24.9% less likely to reported receiving the HPV vaccine compared to higher income women. These results are consistent with the original hypothesis and the findings from

MacLaughlin et al.'s (2022) study. These results imply various factors, such as household income, affect HPV screenings and HPV vaccine uptake.

Finally, the study revealed an association between educational attainment and HPV vaccination uptake among women in the sixth research question. These findings are consistent with the original hypothesis and Amboree et al. (2021), indicating disparities in education and awareness concerning HPV vaccines in women. Hence, women with higher education are more knowledgeable about acquiring required vaccines.

Public Health Implications

Cervical cancer is prevalent among women in the United States and predominately affects women from lower SES and minority populations. Numerous studies illustrated that, despite the preventative measures for cervical cancer, and it is the fourth most common cancer diagnosed in women worldwide (WHO, 2022). Former studies demonstrated that Non-Hispanic Black and Hispanic women are at a higher risk of cervical cancer; moreover, women from these populations have an increased risk of death because of the absence of preventative measures (Ghebre et al., 2021).

The findings from this current study reveal the need for public health professionals to address these populations to preventing cervical cancer. In this study, it was found that race/ethnicity, income, and education make a woman more susceptible to cervical cancer. Public health advocates should take further action to reduce cervical cancer incidence and mortality rates by reinforcing healthier lifestyles that can help reduce the risk of cervical cancer with primary and secondary prevention strategies. For instance, women in underserved communities should be educated on eating healthier, being physical activity, HPV vaccinations, and cervical cancer screenings. Most importantly, public health professionals should educate women about

what HPV and cervical cancer are and inform women when to seek a doctor if they notice symptoms or discomfort. This study implied a need for evidence-based intervention to aid researchers and health educators in comprehending the disparities that affect women, further supporting research indicating how these disparities affect their access to knowledge and health care services (Shin et al., 2021).

Health educators must be conscious of a community's cultural background and its impacts when addressing the disparities in cervical cancer screening and HPV vaccine uptake. Additionally, it is vital for healthcare providers to be educated to reduce the rates of this preventable cancer by promoting healthier lifestyle decisions and reminding and encouraging screenings and vaccine knowledge. For instance, Asians cultural beliefs has led a stigma of HPV screenings and HPV vaccines are linked to encouraging sex due to the lack of understanding. Public health officials and health professionals must recognize the barriers to preventative measures for cervical cancer and HPV. The obstacles identified in the Asian community include: a lack of understanding of the importance of preventative screenings, lack of health care professionals with Asian language skills, cultural emphasis on family instead of individual well-being, religious beliefs, and fear of finding a health condition for which there is no cure (Gor et al., 2017). Therefore, with this research findings, health education should implement changes in the educational materials to make them culturally relevant, provide information in various languages, and have the appropriate level of health literacy (Gor et al., 2017).

Local and government organizations can collaborate to access different racial/ethnic and SES populations' needs. There should be efforts to increase accessibility to healthy food, transportation services to nearby clinics and hospitals, and health interventions so that women can collect further health information and/or seek the medical attention they need. Health

educators should also provide the current available resources to the populations they serve. They can partner with other organizations to advocate for more funding and resources to meet vulnerable and disadvantaged populations' needs. Health promotion and education must be implemented within the underserved communities to address the disparities in women's health. The findings of this study have illustrated Black women have lower rates in HPV screening and HPV vaccinations. Previous results have demonstrated Black women do not trust health care professionals and government agencies (Ojeaga et al., 2019). The Black community attain their information from religious organizations, family and friends, and television (Ojeaga et al., 2019). Therefore, religious organizations should be the first to increase HPV knowledge and, most importantly, cancer communication preferences (Ojeaga et al., 2019). The health education should be delivered in a manner that is tailored for Black women that expresses the relationship between HPV infection and cervical cancer (Ojeaga et al., 2019). Hence, primary and secondary preventative measures are crucial to be practiced.

Studies have implied that public health and healthcare professionals should implement more efforts to promote cervical cancer screening and HPV vaccination at the state and national levels to decrease cervical cancer incidence. Well-organized communication campaigns and the implementation of social media to promote and spread awareness have been successful in the past (Vorsters et al., 2017). Clinical marketing is a way of communicating effectively with the public to provide evidence supporting vaccines' success in preventing incidence of diseases (Vorsters et al., 2017). Moreover, research has indicated that when health care and public health professionals utilize specific evidence-based strategies to provide correct information and training, they assist in prevention efforts and increase individuals' understanding of the risks and benefits of HPV vaccination (Vorsters et al., 2017).

Increasing cervical cancer screenings through population-based programs has been highly effective. Nonetheless, the barriers to screening remain, and public health officials must be aware of the need to increase access to screenings for vulnerable populations and their affordability (Vorsters et al., 2017). Vorsters et al. (2017) stated self-sampling for cervical cancer screening may improve screening rates while also guaranteeing women's convenience and control and reduce costs (Vorsters et al., 2017). Promoting primary and secondary prevention efforts can decrease cervical cancer morbidity and mortality rates.

Study Limitations

In this study, there were several limitations. The BRFSS is a self-reported survey; hence, participants can answer with bias. While answering the survey, participants might have been untruthful when answering questions. Additionally, participants might have had difficulty remembering the correct answer to a question, leading to recall bias. For instance, with the HPV vaccination series, many individuals might not have recalled the vaccines they received during their adolescent years, creating difficulty in remembering and result in response error.

A cross-sectional design was used in this study; however, this design is a limitation because it only evaluates the relationships through groups at a specific time frame that is being measured. Additionally, a cross-sectional approach is susceptible to biases when studying the relationships (Setia, 2016). One must be cautious when interpreting the associations from cross-sectional studies (Setia, 2016). This research aimed to evaluate the associations between the dependent and independent variables; however, causation could not be determined due to the cross-sectional nature of the study. Selection bias might have impacted the results, because the survey did not include the entire population. Therefore, a cross-sectional survey might not have been the most suitable design to grasp all the disease trends.

There was also a possibility for a type I error due to the large sample size. Future research may want to study males and females who may understand a more comprehensive questionnaire; to reduce the sample size. The HPV test, HPV vaccines, race/ethnicity, income, and education were significant and overpowered. If the study utilized fewer participants, then the normal distribution of the results might not have been met, which is an assumption of the chi-square test.

Future research should use a longitudinal study design to improve data quality. A longitudinal study design would help to establish the causation of the disease incidence. The last recommendation is to run separate analyses for the variables with higher responses in the survey versus the questions with lower answers.

Conclusion

This study provided evidence that concurred with previous research. There is a correlation between HPV screenings, HPV vaccinations, race/ethnicity, income, and educational attainment. Findings from this study may be valuable for comprehending the relationships between HPV tests and HPV vaccine intake and the contributing factors of race/ethnicity, income, and education among women. Lastly, HPV screenings and HPV vaccines are crucial steps to preventing infections, protecting the spread of HPV, and, most notably, reducing the incidence and morbidity of cervical cancer in underserved communities.

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Appendix: Tables

Table 1

Demographics for Sample Used to Analyze HPV Vaccination Related Research Questions

(n=7,198)

		<i>N</i>	<i>%</i>
Ethnicity			
	Non-Hispanic White	4124	57.3
	Non-Hispanic Black	1489	20.7
	Hispanic	1019	14.2
	Non-Hispanic Other Race	259	3.6
	Non-Hispanic Asian	233	3.2
	Non-Hispanic American Indian/Alaskan Native	74	1
Age Ranges			
	Ages 18-24	1036	14.4
	Ages 25-34	2062	28.6
	Ages 35-44	2603	36.2
	Ages 45-49	1497	20.8
Education Level			
	High school graduation or below	2017	28.1
	Attending some college or above	5161	71.9

Note. N= sample size, %= percentage. Source: Behavior Risk Factor Surveillance Survey (BRFSS), 2020.

Table 2*Demographics for Sample Used to Analyze HPV Screening Related Research Questions**(n=4,521)*

		<i>N</i>	<i>%</i>
Ethnicity			
	Non-Hispanic White	3336	73.8
	Non-Hispanic Black	399	8.8
	Hispanic	445	9.8
	Non-Hispanic Other Race	136	3.5
	Non-Hispanic Asian	106	2.3
	Non-Hispanic American Indian/Alaskan Native	79	1.7
Age Ranges			
	Ages 18-24	282	6.2
	Ages 25-34	512	11.3
	Ages 35-44	621	13.7
	Ages 45-54	647	14.3
	Ages 55-64	846	18.7
	Ages 65 and over	1613	35.7
Education Level			
	High school graduation or below	1446	32.1
	Attending some college or above	3065	67.9

Note. N= sample size, %= percentage. Source: Behavior Risk Factor Surveillance Survey (BRFSS), 2020.

Table 3*Kruskal-Wallis H Test Comparing HPV Screening Across Race/Ethnicity Categories*

	N	df	p
Have you ever had an HPV test across race/ethnicity categories	4521	5	.001

Note: The significance level is $p < .050$

Table 4*Bivariate Association between Income Level and HPV Screening*

HPV Test	Yes HPV Test n (%)	No HPV Test n (%)	Adjusted OR 95% CI
Low Income	425 (41.5%)	1285 (47.8%)	0.77
Higher Income	600 (58.5%)	1402 (52.2%)	(.83, 1.07)

Note. OR= Odds Ratio; CI= Confidence Interval. The Chi-square Test of Independence did reveal a significant relationship between Income and HPV Test. $*p < .001$. Source: Behavior Risk Factor Surveillance Survey (BRFSS), 2020.

Table 5*Bivariate Association between Education Level and HPV Screening*

HPV Test	Yes HPV Test n (%)	No HPV Test n (%)	Adjusted OR 95% CI
High School & Below	516 (35.7%)	1444 (47.1%)	0.62
Some College & Above	930 (64.3%)	1621 (52.9%)	(.72, 1.2)

Note. OR= Odds Ratio; CI= Confidence Interval. The Chi-square Test of Independence did reveal a significant relationship between Education Level and HPV Test. $*p < .001$. Source: Behavior Risk Factor Surveillance Survey (BRFSS), 2020.

Table 6*Kruskal-Wallis H Test Comparing HPV Vaccination Across Race/Ethnicity Categories*

	N	df	p
Have you ever had an HPV vaccination across race/ethnicity categories	7197	5	.001

Note: The significance level is $p < .050$

Table 7*Bivariate Association between Income Level and HPV Vaccine*

HPV Test	Yes HPV Vaccine	No HPV Vaccine	Adjusted OR
	n (%)	n (%)	95% CI
Low Income	381 (24.9%)	1202 (26.8%)	0.91
Higher Income	1150 (75.1%)	3284 (73.2%)	(.93, 1.03)

Note. OR= Odds Ratio; CI= Confidence Interval. The Chi-square Test of Independence did reveal a significant relationship between Income Level and HPV Vaccine. $*p < .001$. Source: Behavior Risk Factor Surveillance Survey (BRFSS), 2020.

Table 8*Bivariate Association between Education Level and HPV Vaccine*

HPV Vaccine	Yes HPV Vaccine n (%)	No HPV Vaccine n (%)	Adjusted OR 95% CI
High School&Below	464 (23.0%)	1414 (27.4%)	0.8
Some College&Abov	1553 (77.0%)	3747 (72.6%)	(.84, 1.07)

Note. OR= Odds Ratio; CI= Confidence Interval. The Chi-square Test of Independence did reveal a significant relationship between Education Level and HPV Vaccine. $*p < .001$. Source: Behavior Risk Factor Surveillance Survey (BRFSS), 2020.