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Low Health Literacy and HPV Vaccine Uptake of African American and Hispanic American Women

Peter Ntiamoah
Walden University

Walden University

College of Health Sciences

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Peter Ntiamoah

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Review Committee
Dr. Frazier Beatty, Committee Chairperson, Public Health Faculty
Dr. Precilla Belin, Committee Member, Public Health Faculty
Dr. LaToya Johnson, University Reviewer, Public Health Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
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Abstract

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MPH, Walden University, 2011

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of the Requirements for the Degree of

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Public Health - Epidemiology

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Abstract

Cervical cancer incidence in the United States has declined for the past 40 years, yet the odds of developing cervical cancer is much higher among marginalized women, particularly African American and Hispanic American women. Although preventable through vaccination against the human papillomavirus (HPV) prior to infection, uptake and completion rates of the vaccine among African American and Hispanic American women are low. The purpose of the study was to determine if a significant relationship existed between the health literacy levels of African American and Hispanic American women, ages 18–26, and the low HPV vaccination uptake. The integrated behavioral model, which identifies factors antecedent to behavioral intention, as well as the motivating variables, was the theoretical framework. Secondary data from the 2015 National Health Interview Survey were used to examine the relationships among the variables of interest. A logistic regression (n = 2093) showed that health literacy is a strong determinant of HPV vaccine behavior intention, and that there was a significant relationship between health literacy and HPV vaccine initiation. Health literacy mediated the relationships between the motivating variables and the vaccine uptake, and completely mediated the relationship between ethnicity and HPV vaccine uptake. Health literacy did not independently predict the vaccine initiation. The findings from this study might (a) provide public health practitioners with enough information to guide health promotion activities to increase the vaccination coverage to the level expected in *Healthy People 2020*, (b) save economic resources through cancer prevention, and (c) improve lives by curbing the excess deaths among racial minority women.

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Dedication

This dissertation is dedicated to my wife, Barbara Tallula Ntiamoah, and my three adorable children, Jeremiah, James, and Janyce.

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I wish to express my sincere appreciation to special people who contributed in many diverse ways to make my dissertation a success. I stand at the pinnacle only because the Lord Almighty granted me the strength and many people held my hand. Many others selflessly offered their shoulders to carry me through the journey. My first appreciation goes to my dissertation chair, Dr. Frazier B. Beatty, whose guidance, patience, encouragement, prompt responses to all dissertation concerns, deep understanding of methodology, and commitment to academic excellence made it possible for me to complete this study successfully. I also wish to thank my committee member, Dr. Precilla Belin, for her invaluable input into the content and organization of this dissertation. My appreciation also goes to Dr. LaToya Johnson, the URR whose contributions and expertise ensured that this dissertation met Walden University's highest doctoral standard. I am grateful to Barb Elwert for her awesome edit of my dissertation.

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Chapter 1: Introduction to the Study

According to the Centers for Disease Control and Prevention (CDC, 2017), almost 79 million Americans are infected with the human papillomavirus (HPV), and approximately 14 million people become infected each year. Women from racial and ethnic minorities who also have a low-income status have higher risk factors for contracting HPV (Lin et al., 2015). Persistent infection of the oncogenic HPV strains accounts for more than 90% of cervical cancer cases. The excess incidence and death rates of cervical cancer among women from racial minorities reflect the racial and ethnic disparities in the risk factors and the ability of the women to acquire and act on appropriate health information (CDC, 2016; Lin et al., 2015).

Currently, cervical cancer screening and HPV vaccination are the two strategies available to prevent cervical cancer (Institute Catala d'Oncologia, 2017), and since 2006, the U.S. Food and Drug Administration (FDA) has approved three HPV vaccines: Gardasil, Gardasil 9, and Cervarix. All three vaccines prevent infection of the two most virulent HPV types, namely, 16 and 18. Unfortunately, the HPV vaccination rates among young adult women from racial minorities lag behind that of their European American counterparts (William et al., 2017). Studies to address this disparity have mostly focused on single variables such as these four: knowledge of HPV and HPV vaccine (Marchand, Glenn, & Bastani, 2012; Navalpakam, Dany, & Hajj Hussein, 2016; Ratanasiripong, Cheng, & Enriquez, 2013; Ziemer & Hoffman, 2013); HPV vaccine awareness (Blake et al., 2015; Price, Tiro, Saraiya, Meissner, & Breen, 2011; Strohl et al., 2015; Yi, Lackey, Zahn, Castaneda, & Hwang, 2013); access to health care (Luque, Castañeda, Tyson,

Vargas, & Meade, 2012; Sørensen, Van Den Broucke, Fullam, Doyle, & Pelikan, 2012; Sun et al., 2013); and attitudes toward vaccination (Britt, Collins, Wilson, Linnemeier, & Englebert, 2015; Dempsey, Fuhrel-Forbis, & Konrath, 2014; Ziemer & Hoffman, 2013). Although each of these studies has contributed to the body of knowledge, the racial and ethnic disparity in vaccine coverage has indicated the need to consider the relationship of other variables comprising multiple sociodemographic factors and HPV vaccine uptake. Results gleaned from this study will become part of the building blocks in health promotion programs that target young adult women ages 18 to 26, from racial and ethnic minority communities.

I conducted this study to determine the relationship between health literacy (HL) levels and HPV vaccine uptake among noninstitutionalized, civilian young adult women between 18 and 26 years of age from racial minorities (African American and Hispanic American) who were living in the United States at the time of the study. I applied Martin et al.'s (2009) predictive HL model on the publicly available data set from the National Health Interview Survey (NHIS, 2015) to compute the individual HL levels, and I used quantitative data analysis to further identify the type of relationship between the derived HL and HPV vaccine uptake.

Background of the Study

Respectively, African American and Hispanic American women have cervical cancer incidence rates that are 41% and 44% higher than European American women do (Daniel-Ulloa, Gilbert, & Parker, 2016). Between 2000 and 2004, the annual rates of cervical cancer among African American, Hispanic American, and European American

women per 100,000 women were 11.4, 13.8, and 8.5, respectively, compared to 8.7 per 100,000 of the general population of women in the United States (National Cancer Institute [NCI], 2008). The annual death rates of cervical cancer per 100,000 women were 4.9 for African American women, 3.3 for Hispanic American women, and 2.3 for European American women between 2000 and 2004 (NCI, 2008). Recent researchers have found less racial variation in cervical cancer screening among racial and ethnic minority women and their European American counterparts (King, Chen, Garza, & Thomas, 2014; Saslow et al., 2012). Conversely, HPV vaccination rates among women from medically underserved minorities have ranged between 24% and 25%, far less than the *Healthy People 2020* target goal of 80% (Bakir & Skarzynski, 2015). The disproportionate vaccination coverage has been attributed to minority women's low knowledge of HPV (Navalpakam et al., 2016); insufficient awareness of the HPV vaccine (Blackman et al., 2013); uncertainty about the efficacy of the vaccine and concern about its safety (Gelman et al., 2013; Ojinnaka et al., 2017; Patel et al., 2012; Price et al., 2011); and normative factors such as expected societal beliefs or behaviors (Ratanasiripong et al., 2013; Ziemer & Hoffman, 2013). Despite the confirmation by Yang and Bracken (2016) that the HPV vaccine significantly reduces the incidence of HPV infection, the low socioeconomic status (SES), low HL levels, insufficient information, and misinformation of women from racial minorities affect their ability to access information and make appropriate health decisions for themselves and their families (Betsch et al., 2012; Clay, 2009; Keelan, Pavri, Balakrishnan, & Wilson, 2010; Rikard, Thompson, McKinney, & Beauchamp, 2016; Sharby, Martire, & Iversen, 2015).

Problem Statement

The low levels of HL among women from racial minorities in the United States might be contributing to the increased incidence of cervical cancer among African American and Hispanic American women. Persistent infection of HPV accounts for more than 90% of cervical and anal cancers; 70% of oropharynx, vaginal, and vulva cancers; and 60% of penile cancers (CDC, 2016b). Between 2008 and 2012, HPV-associated cervical cancer incidence rates among African Americans, Hispanic Americans, and European Americans were 9.2, 9.7, and 7.1 per 100,000, respectively (Viens et al., 2016); and the incidence rates were 41% and 44% higher among African American and Hispanic American women, respectively, with European American women as the referent (American Cancer Society [ACS], 2015, 2016). From 2009 to 2013, the age-adjusted cervical cancer mortality rates among African American, Hispanic American, and European American women were 3.9, 2.6, and 2.1 per 100,000, respectively (U.S. Cancer Statistics Working Group, 2016). The FDA approved the first HPV vaccine for women ages 12 to 26 years in 2006 to help to address the increasing trend (CDC, 2016c). Unfortunately, African American women are 30% less likely to initiate the vaccine uptake, and Hispanic American women are 62% less likely to complete the required vaccine series (Daniel-Ulloa et al., 2016).

The review of the literature indicated that previous research on HPV vaccine uptake disparity has focused mainly on SES factors (Giorgi Rossi, Baldacchini, & Ronco, 2014; Perkins, Brogly, Adams, & Freund, 2012); individual beliefs or experiences with vaccines (Baker et al., 2012; Cates, Brewer, Fazekas, Mitchell, & Smith, 2009); and

cultural factors coupled with lack of awareness (Blackman et al., 2013; Daley et al., 2010; Notaro, 2012). Each of these researchers focused on single-factor determinants, and so far, the individually focused factors have not been able to close the disparity gap. To date, only 24.4%, 25.0%, and 34.0% of African American, Hispanic American, and European American women, respectively, have initiated the first HPV vaccine dose. Such rates are much lower than the *Healthy People 2020* vaccine goal of 80% (ACS, 2016b; Daniel-Ulloa et al., 2016; Elam-Evans et al., 2014).

There has been little to no research available on the ways that low HL, which encompasses vaccination intention and motivation to perform the behavior, affects the HPV vaccine uptake among marginalized women. Veldwijk et al. (2015) recommended measuring HL levels when studying vaccination decision behaviors. The disparity in HPV vaccine uptake rates might be due to low HL levels in marginalized communities, especially when considering that 24% and 41% of African American and Hispanic American adults, respectively, have HL level skills that are below basic and that only 2% and 4% of African American and Hispanic American adults, respectively, have proficient HL levels (Kutner, Greenberg, Jin, & Paulsen, 2003). Understanding the effect of low HL at the individual or community level on HPV vaccine uptake might lead to the development of potential strategies to increase the vaccine uptake and reverse the high incidence rates of cervical cancers among minority women in low-SES communities.

Purpose of the Study

The purpose of this study was to determine the relationship between HL and HPV vaccine uptake among young adult African American and Hispanic American women

between the ages of 18 and 26 years who were living in the United States at the time of the study. The integrated behavioral model (IBM) was the theoretical framework of the study. HL refers to the level to which individuals acquire or access health information and processes and makes health-related decisions for themselves or family members. HL level was the independent variable (IV) in the study. According to Nutbeam (2000), HL level can be classified as functional, interactive, or critical in reference to the ability to transmit factual health information on health risks, create opportunities to develop skills to interact with and influence social norms, and act on SES determinants of health, respectively. HPV vaccine initiation (dose ≥ 1) was the dependent variable (DV), or outcome variable, in this study. SES (i.e., income and education attainment) and age were among the potential confounding variables that were controlled during the data analysis. Attitude toward HPV vaccine, perceived norm, and personal agency were factored into the computation of the HL scores using specific sociodemographic variables. The research questions (RQs) were designed to examine the relationship between HL level and HPV vaccine uptake in order to strengthen the knowledge base, promote and influence social change in vaccine uptake planning, and possibly generate new ideas to improve the HPV vaccine uptake (Newman, Ridenour, Newman, & DeMarco, 2003).

Research Questions and Hypotheses

The two RQs and hypotheses were as follows:

1. Does HL level relate to the HPV vaccine uptake of marginalized adolescent and young adult women, ages 18 to 26 years living in the United States, after controlling for the effects of income, educational level, and age?

H_{01}: There is no significant relationship between HL and HPV vaccine uptake among marginalized adolescent and young adult women, ages 18 to 26 years living in the United States, controlling for the effects of income, educational level, and age.

H_{a1}: There is a significant relationship between HL and HPV vaccine uptake among marginalized adolescent and young adult women, ages 18 to 26 years living in the United States, controlling for the effects of income, educational level, and age.

2. Does ethnic background relate to the HPV vaccine uptake of marginalized adolescents and young adult women, ages 18 to 26 years, living in the United States, after controlling for the effects of income, educational level, and age?

H_{02}: There is no significant relationship between ethnic background and HPV vaccine uptake of marginalized adolescent and young adult women, ages 18 to 26 years living in the United States, controlling for the effects of income, educational level, and age.

H_{a2}: There is a significant relationship between ethnic background and HPV vaccine uptake of marginalized adolescent and young adult women, ages 18 to 26 years living in the United States, controlling for the effects of income, educational level, and age.

Theoretical Framework

Integration of the seven constructs agreed upon by behavioral theorists, including Bandura, Fishbein, Becker, and Triandis in the early 1990s at the National Institutes of

Mental Health's workshop on AIDS into Fishbein's (1967) theory of reasoned action (TRA) and Ajzen's (1991) theory of planned behavior (TPB), is known as the IBM (Branscum & Bhochhibhoya, 2016; Fishbein et al., 1992; Glanz, Rimer, & Viswanath, 2008). The IBM served as the theoretical framework of the study. IBM is an emerging health behavior theory that combines elements from the four most popular behavioral change theories—social cognitive theory, transtheoretical model, information-motivation-behavioral skills model, and the TPB—all of which collectively can offer guidance to public health intervention programs (Michie, West, Campbell, Brown, & Gainforth, 2014). The IBM can be used deductively to assess factors that might affect a person's ability to acquire, process, and act on health-related information. The IBM posits that behavioral intention is antecedent to behavior and that the intention to perform behaviors is influenced by the independent interactions of experimental and instrumental attitude, perceived control and self-efficacy, and injunctive and descriptive norms (Ajzen, 1991; Glanz et al., 2008). Madden, Ellen, and Ajzen (1992) asserted that behavioral intention always precedes behavior and that subjective norms as well as attitude toward the behavior combine to influence the intention. Thus, favorableness or unfavorableness toward behavior, perceived normative expectations, and perceived self-efficacy determine behavioral intention (Glanz et al., 2008).

Besides intention to perform behaviors, the IBM identifies other motivating factors, namely, sufficient knowledge and skill to perform the behaviors, absence of environmental constraints, salience of the behaviors, and existing habits of performing the behaviors (Glanz et al., 2008; Olin et al., 2010). Demographic characteristics,

attitudes toward target behaviors, personality traits, and individual differences are among the background factors of the indirect variables that might play significant roles in influencing behaviors (Michie et al., 2014). According to Fishbein and Ajzen (2011), the integrated behavioral theory is a value-expectancy model that identifies the cognitive pathways of factors that precede and influence behavioral intentions.

Nature of the Study

I followed a quantitative method to examine the relationships between and among the variables using secondary data from the NHIS (2015) on the general population to ascertain the general health information of noninstitutionalized civilian residents of the United States. The DV in this study was dichotomous (HPV vaccine initiation—yes/no), and the IVs (HL and ethnicity) were categorical variables. The secondary data contained sociodemographic information on participants who had received at least one dose of the HPV vaccine. To compute the participants' HL levels, I used sociodemographic characteristics such as age, gender, ethnicity, highest educational attainment, income level, marital status, English fluency, and place of birth. To identify variables that could help racial minority women act upon their health intentions, I assessed factors such as cancer prevention knowledge, accessibility and utilization of health care services, and environmental barriers. All the sociodemographic characteristics needed to compute the HL levels, and the motivational variables to assess the mediating effects were available in the existing NHIS data sets.

Definitions of the Study Variables

Health literacy: "The degree to which an individual can obtain, communicate, process, and understand health information and services in order to make appropriate health decisions" (Somers & Mahadevan, 2010, p. 7). Nutbeam (2000) described the three levels of HL: functional, interactive, and critical. Critical HL transcends the functional and interactive levels, and it comprises personal and community responsibilities that apply individual cognitive skills and societal empowerment to determine the degree to act on health information (Guzys, Kenny, Dickson-Swift, & Threlkeld, 2015; Nutbeam, 2000).

HPV vaccine uptake: Defined in this study as any acceptance of the HPV vaccine dose (≥ 1 dose) that did not matter whether or not the individual completed all the three doses. Participants who failed to respond to the survey item or did not know their vaccination status were excluded from the statistical analysis.

Racial minority: Refers to women between the ages of 18 and 26 years who self-identified as either Hispanic American or African American heritage. For the purposes of this study, African American included women of an African American ethnic background as well as immigrants of the same age group from Africa, the Caribbean, and English-speaking countries in South and Central America. Similarly, Hispanic American women in the study included immigrants from South and Central America who identified themselves as Hispanic in the survey. Immigrants from Spain living in the United States were not considered Hispanic American.

Rationale for the Study

As of 2016, the breakdown of the U.S. population was as follows: 76.9% European American, 17.8% Hispanic American or Latino American, and 13.3% African American (U.S. Census Bureau, 2016). By 2050, the African American and Hispanic American populations are expected to be 13.0% and 29.9% of the total population, respectively (Rodriguez et al., 2014).

Despite their growth, 24% and 41% of the African American and Hispanic American populations in the United States, respectively, have HL below the basic level (Kutner et al., 2003). A positive association between the low SES of ethnic minorities and low HL levels also has been identified (Rikard et al, 2016). Current HPV vaccination strategies that focus on the individual factors without considering the societal component have not been adequate. Understanding the relationship between HL level and HPV vaccine uptake could improve the vaccination coverage and prevent cervical cancer incidence and deaths among women from racial minorities.

Assumptions

Quinn, Jamison, Musa, Hilyard, and Freimuth (2016) posited that complacency, convenience, and confidence contribute to influenza vaccine hesitancy among African Americans. In this study, I assumed that there was no difference between minority women and their European American counterparts regarding convenient access to HPV vaccine information. Without this assumption, then any difference in the vaccination rates between the two groups might have been explained by the European American women's convenient access to the vaccine (Saslow et al., 2012). Another assumption was

that any vaccine hesitancy behavior was not influenced by any factor outside each participant's sociodemographic characteristics. Thus, the participants in the study did not have any prior bad experiences with the health care services, and there were no underlying medical conditions to prevent them from getting the HPV vaccine (CDC, 2017; Dubé et al., 2013).

Scope and Delimitations

I focused my investigation on noninstitutionalized, civilian, racial minority women between the ages of 18 and 26 years who were living in the United States at the time of the study. Members of this population cohort are at risk because many are sexually active but continue to face challenges in their ability to acquire and act on health information. Young adult women are expected to be able to navigate the complex health care system for reproductive health information, evaluate the information, and act on it.

Although the HPV vaccine was approved for females between the ages of 9 and 26 years, HL level, however, is measured in adults only. Health decisions for children and adolescents below the age of 18 years are controlled by parents, so the HL level of adolescents ages 16 and 17 years will not depict any relationship that might exist with HPV vaccine uptake.

Women over 26 years of age were not included in this study because clinical trials of the HPV vaccine did not show any benefit for women over the age of 26 years (CDC, 2017). The study also did not include the HPV vaccination rates for men. Cervical cancer is caused by persistent infection of the virulent strains, types 16 and 18. Female vaccination against the virus prevents such persistent infection of the cervix.

Institutionalized minority women and those in the military were excluded because of accessibility issues and ethical concerns.

Limitations

I was unable to establish the validity of the participants' responses to the survey items, an issue that could have introduced misinformation bias or misclassification. Crucial information regarding risky sexual behaviors and other activities that was not collected during the interviews limited the analysis and interpretation of the results. The lack of triangulation of the participants' responses could have introduced self-reporting bias and social desirability bias. Although less than 10% of the sample had missing data on key valuable variables, that small percentage reduced the sample of the study. The findings might not be generalizable to countries outside the United States. Cases with missing data on key variables needed to determine the HL level or information on HPV vaccine uptake were deleted, listwise—a statistical technique that removes all data for cases with one or more missing values from the statistical analysis.

Significance

The FDA licensed the HPV vaccine in 2006, yet the average national vaccine uptake rate in 2013 was 57.3%, which was lower than the 80% target rate set by *Healthy People 2020* (as cited in Elam-Evans et al., 2014). A 2013 NHIS of 6,444 participants between the ages of 18 and 30 years reported that 34.0%, 24.4%, and 25.0% of European American, African American, and Hispanic American women, respectively, initiated the first HPV vaccine dose (as cited in Daniel-Ulloa et al., 2016). Among the women who started the first dose, more than three quarters of the European American women

completed the recommended three doses, compared to completion rates of 42.8% and 62.4% among the African American and Hispanic American women, respectively (Daniel-Ulloa et al., 2016). The recommended strategies to overcome HPV vaccination barriers approved on June 9, 2015, by the National Vaccine Advisory Committee (NVAC) did not identify HL as an obstacle to vaccine uptake. The NVAC recommendation was contrary to the suggestion to consider levels of HL in vaccination promotion programs (Veldwijk et al., 2015). This public health problem was articulated within the IBM framework so that the findings may become part of the building blocks in the public health discipline to develop health promotion programs. Thus, the results of this study, which examined the relationship between HL and HPV vaccine uptake in the identified population, is expected to add to the body of science and perhaps offer recommendations to reduce the prevalence of HPV-related cancers.

According to Getzen (2013), economic resources are limited and are under considerable budgetary restraints. Instead of spending more than $8.0 billion (2010 U.S. dollars) on direct medical costs in screening for and treating cervical cancers, understanding the relationship between the HL levels and HPV vaccine uptake is expected to influence public health intervention strategies. Thus, prevention efforts through vaccination will cost between $390 and $450 per vaccine series per person to prevent the onset of cancer (Association of Reproductive Health Professionals, n. d.).

Implications for Social Change

Results of this study will add to the body of knowledge in public health regarding the antecedents and consequences of HL about HPV vaccine uptake among racial

minority young adult women ages 18 to 26 years in the United States. The study also will give public health practitioners information that will help them to understand the factors that influence behavioral intentions toward uptake of the HPV vaccine as well as factors within the complex health care system that hinder the HL of African American and Hispanic American women as they begin their adulthood lifestyles.

Summary

Cervical cancer incidence and death rates are prevalent among racial minority (i.e., African American and Hispanic American) women. Persistent infection of the high-risk strains of HPV (i.e., types 16 and 18) account for more than 70% of cases of cervical cancer, yet the protective HPV vaccine coverage among African American and Hispanic American women is far below the expected vaccination goal set by *Healthy People 2020* (Bakir & Skarzynski, 2015; Lin et al., 2015; Yoo et al., 2017). Most extant literature has focused on single variables to help to explain disparities in vaccine coverage. However, there have been some limited articles on the relationship between HL and HPV vaccine uptake among racial minority women. Current NVAC (2015) guidelines to improve HPV vaccine uptake have not identified low levels of HL among the minority population as a barrier.

Using the IBM, the purpose of this study was to analyze secondary quantitative data from the NHIS (2015) to assess whether there was a significant relationship between HL levels and HPV vaccine uptake among the target population. Knowledge gained from this study will contribute to the body of knowledge to guide health promotion programs.

Preview to the Remaining Chapters

To further understand current knowledge regarding the HPV vaccine uptake, health literacy, and the factors that generally influence vaccination, I conducted an extensive literature review from peer-reviewed journals. Quantitative data analyses that included multivariable logistic regression were performed on the publicly available data of the 2015 NHIS to examine the relationships between the variables. The findings from this study were then compared to the current knowledge to assess whether they were congruent with the literature and provided possible explanation to any observed discrepancies.

Chapter 2: Literature Review

Chapter 2 focuses on peer-reviewed articles addressing the major IVs of ethnicity, HL and its determinants, the DV of HPV vaccine uptake, and the relationships between and among the variables. Most of the literature discussed comprises articles and other sources published in English since 2011. The articles selected for review were identified using PubMed, EBSCO, SAGE, and ScienceDirect. Keywords used to search for relevant literature were *HPV vaccine*, *ethnic minority*, *college women*, *young adult women*, *health literacy*, *health knowledge*, *HPV vaccine awareness*, *cervical cancer prevention*, and *normative influences*.

Literature Review: Overview

Health professionals usually assume that individuals between the ages of 18 and 26 years possess the basic health skills needed to obtain health-related information to make health decision either for themselves or family members. However, the complex interactions between individual factors such as literacy skills, health knowledge, sociocultural factors, and past experiences, and the established health care system (i.e., health care practitioners, health care infrastructure, and quality of health care workforce) that work together to influence HL levels have not been adequately explored. The individual determinants of HL directly influence the capacity of individuals to use and act on health information (Sørensen et al., 2012). Factors that determine HL levels are not limited to basic literacy; rather, the complex interactions and communications between individuals and the current health care infrastructure, together with the available social capital, affect the degree to which individuals can acquire and apply health information

(McCray, 2005). For instance, the cultural and linguistic skills of patients and professional providers, including the use of scientific vocabularies and epidemiologic jargon, can contribute to HL levels (Singleton & Krause, 2009; Sun et al., 2013). Sociodemographic characteristics, such as gender, ethnicity, marital status, age, education, and income, have been identified as the basic determinants of HL (Martin et al., 2009; Sun et al., 2013). Research that has focused on such individual factors, such as HPV and HPV vaccine knowledge, awareness, attitudes, beliefs, and access to health care, have not fully explained the low HPV vaccine uptake among African American and Hispanic American women.

Literature Related to Content

The 2007 Paasche-Orlow and Wolf conceptual model of explaining the relationship between low levels of HL and health outcomes posited that health care access and utilization, individual self-care, and the complex interaction between patients and providers could impact health outcomes significantly (as cited in Sun et al., 2013). Young adult women who not too long ago were considered adolescent minors are now expected to have the ability to access general health information, make significant decisions about clinical issues, and also acquire the skills needed to assess information about risk factors in order to prevent disease (Sørensen et al., 2012). Many variables influence the ability to adopt healthy behaviors. According to the IBM, factors such as normative and subjective beliefs, attitudes towards behaviors, perceived control and self-efficacy, knowledge about replacement behaviors such as an increase in vaccine uptake,

and environmental conditions contribute to the intention and ability of individuals to perform the desired behaviors (Glanz et al., 2008).

Ratanasiripong et al. (2013) conducted a cross-sectional study and concluded that young college women would accept a mandated HPV vaccine for people between the ages of 18 and 26 years. The researchers applied Ajzen's (1991) TPB to identify the variables that influenced the young college women's decision to accept the HPV vaccine. The TPB is an extension of the constructs of the TRA (attitude and subjective norms), and the TPB includes perceived control to address situations in which individuals might not have complete volitional control (Glanz et al., 2008). Using a sample of convenience, Ratanasiripong et al. recruited 384 (175 unvaccinated and 209 vaccinated) college women, ages 18 to 26 years from a public university in southern California. Targeted students who received an e-mail from researchers and consented to participate in the study were directed to a website to complete a self-administered questionnaire that measured participants' attitudes, subjective norms, perceived controls, intention to receive the vaccine (among those unvaccinated), and knowledge about the HPV and HPV vaccine (Ratanasiripong et al., 2013). Cronbach's coefficient alpha of each of their instruments ranged from 0.70 (perceived control) to 0.96 (intention to vaccinate), and a 5-point Likert scale was used to measure all responses. A *t* test for continuous variables and Fisher's exact tests for categorical data showed no significant differences between the vaccinated and unvaccinated participants regarding religion, health insurance status, class major (college courses), Pap smear status, sexually transmitted infection, and relationship status (Ratanasiripong et al., 2013). However, a chi-square test revealed a significant

difference between the vaccinated and unvaccinated groups, regarding race, with 10.4%, 24.3%, and 28.2% of the vaccinated respondents being African American, Latina American, and European American, respectively (Ratanasiripong et al., 2013). After controlling for the significant covariates (age, ethnicity, and age of first sexual intercourse) in a hierarchical multivariate logistic regression, subjective norms (providers' recommendations, support from mothers and peers); attitudes about receiving the vaccine; and perceived control consistently predicted the intention to receive the vaccine.

Despite the self-report of multiple sexual partners, some of the nonvaccinated did not perceive their risk of acquiring HPV, indicating that low knowledge about the virus could impact behavioral beliefs (Ratanasiripong et al., 2013). This study was limited to only one university in California. Nonstudents were excluded, so the findings cannot be generalized to all young adult women. The participants' positive subjective norms, coupled with the positive attitude toward the vaccine mandate, could be explored by public health practitioners to increase the vaccine uptake. Future studies should focus on identifying factors such as environmental constraints, habits, and salience of behaviors that can facilitate intentions of adopting behaviors.

In an exploratory factor analysis from a longitudinal study, Dempsey et al. (2014) used the Carolina HPV Immunization Attitude Scale (CHIAS) to measure the attitudes of a sample of college-age women toward the HPV vaccine. CHIAS is a validated instrument that measures the attitudes of parents with adolescent children toward the HPV vaccine, looking at access, perceived harm, vaccine effectiveness, and uncertainty.

Dempsey et al. recruited 139 unvaccinated college-age participants and administered 16 modified items on the CHIAS to reflect the current population. They performed the data analysis using linear and logistic regressions to assess the associations between the factor structures and HPV vaccination; and logistic regression for the relationship between the factor structures and HPV vaccine uptake. Analysis revealed that the HPV vaccination attitudes regarding perceived harm were similar among young college-age women, ages 18 to 26 years and the parents of adolescent children. Thus, perceived harm about the HPV vaccine strongly predicted vaccine intention and uptake among the two different populations (i.e., parents with adolescent children and college-age women).

Results highlighted the need to address the concern of perceived harm in any public health intervention effort and support additional studies to identify other predictor variables. Although Dempsey et al. (2014) identified a key predictor of young women's attitude to HPV vaccine, they did not address other factors such as SES and environmental factors that affect people's degree of accepting the vaccine. Second, the participants in the study were students, so there might have been selection bias because individuals not in colleges were not represented in the sample.

A cross-sectional study involving 571 unvaccinated young adult women between the ages of 18 and 26 years measured the subjective normative influence of mothers and health care providers on the participants' intention to receive the HPV vaccine (Head & Harsin, 2016). All of the participants were from a large Midwestern university. The breakdown of their representation in the sample was comprised of 82.8% European American, 9.5% African American, and 3.0% Hispanic American. The researchers

assessed participants' vaccination intention by asking questions about past HPV vaccine conversations with their mothers and doctors. Past maternal and physicians' recommendations were categorized into three groups: vaccinate, do not vaccinate, and no conversation. Head and Harsin (2016) measured the participants' HPV vaccine intention on a 4-point Likert-type scale ranging from *very unlikely* to *very likely*, and they treated it as the outcome variable. Past recommendations served as the predictor variable. An ANOVA test indicated that past positive recommendations from mothers and physicians led to stronger intention to vaccinate. The ANOVA result demonstrated that the young women who did not receive any recommendation from their mothers or physicians about HPV vaccination were more likely to receive the vaccine than their counterparts who were told not to do so (Head & Harsin, 2016). A multiple regression model that entered the participants' intent to vaccinate as the outcome variable showed that the recommendation from mothers about the vaccine was the most significant predictor of the dependent variable (DV). Results showed that the subjective normative influence of health care providers and mothers significantly impacted the young women's intentions to vaccinate against HPV (Head & Harsin, 2016).

Head and Harsin (2016) used a theoretical framework that ensured the validity and reliability of the findings to give the assurance needed to guide health education programs. The participants were predominantly European American college students from only one university in the Midwest, so they did not fully represent the tapestry of the U.S. population. The TRA in Head and Harsin's study identified certain factors that are antecedent to the intention. However, the TRA does not address knowledge, skills,

experience, and environmental constraints that might affect the ability to act on the intention (Glanz et al., 2008). Subjective normative factors also can influence the intention to vaccinate against HPV, so future researchers should build on this idea by identifying factors that might facilitate desirable behavior outcomes.

Another study that conveniently sampled college women, ages 18 to 26 years, was conducted by Ziemer and Hoffman (2013), who used the health belief model (HBM) as the conceptual framework to examine attitudes toward the HPV vaccine. The researchers recruited 208 students and sought to identify predictor variables to HPV vaccine intention. The young women in this study, whose mean age was 21.1 years, were recruited in 2010 from five tertiary institutions in the West, Midwest, and Mid-Atlantic to West regions of the United States. The majority of the participants were European Americans, with only 8.7% and 4.3% African Americans and Hispanic Americans, respectively (Ziemer & Hoffman, 2013). The investigators used a survey, measured on a Likert scale, to assess the participants' attitudes toward intention to receive the HPV vaccine. Participants' HPV vaccination status and intentions to receive the vaccine were the outcome variables. The IVs included the six constructs of the HBM (perceived susceptibility, perceived severity, perceived barriers, perceived benefits, self-efficacy, and cues to action); HPV knowledge; sexual risk factors; and subjective norms (Ziemer & Hoffman, 2013). A hierarchical regression model showed that three predictor variables, namely, social environment, self-efficacy, and general perception of the vaccine, significantly predicted the women's intention to vaccinate (Ziemer & Hoffman, 2013). The researchers suggested that positive external factors (i.e., subjective norms)

encouraged the young adult women to get the vaccine, increased their knowledge about the vaccine, minimized barriers, and improved the chances of vaccine uptake. Although Ziemer and Hoffman applied a theoretical framework to study women's attitude to the HPV vaccine, the exclusion of noncollege students did introduce blank elements into the study. Future researchers might wish to explore social and informational environmental factors to increase the likelihood of vaccine uptake.

Instead of recruiting from college campuses only, Casey, Crosby, Vanderpool, Dignan, and Bates (2013) recruited 495 unvaccinated young adult women, ages 18 to 26 years from five primary women's health clinics and four community colleges in southeastern Kentucky counties. Between March 2008 and September 2009, the researchers recruited the participants and then asked them to complete a self-administered questionnaire to assess the normative influences (parents, friends, and health care providers) on the college students.

In anticipation of low functional HL among the women recruited from the health clinics, Casey et al. (2013) administered the same questionnaire to the respondents in an interview-assisted format. They reported a 98% participation rate in this longitudinal study, with 248 participants from the community colleges and 247 from the clinic. After the participants completed the survey, the researchers gave them free vouchers for all three required doses of the HPV vaccine. Each coupon had a code to match the identifier on each completed survey.

The outcome variable was the use of the voucher for the first vaccine dose within 2 months of completing the survey (Casey et al., 2013). The predictor variables included

the possibility of multiple sexual partners; sexual behavior within the past 12 months; a Pap smear; an abnormal Pap smear result; a close family member with cervical cancer; and hormonal contraceptive usage (Casey et al., 2013). The researchers dichotomized the predictor variables as “favorable” and “less favorable,” and they performed a bivariate analysis to determine relationships between and among the variables. A multivariate two-block hierarchical logistic regression with all predictor variables that had achieved alpha values of less than 0.10 in the bivariate analysis identified the associations among the variables. The descriptive analysis showed no significant differences regarding age, sexual behaviors, and clinical history between participants recruited from the clinics and those recruited from the colleges (Casey et al., 2013). The logistic regression revealed that participants with favorable normative support, that is, peer support, paternal encouragement, and health care providers’ recommendations, positively predicted the outcome variable. Participants recruited from the primary health clinics were 60% more likely than the college students to initiate HPV vaccine uptake (Casey et al., 2013). The researchers recommended further exploration of the father-daughter relationship to improve the vaccine uptake among this population.

The strength of Casey et al.'s (2013) study was the use of college-enrolled students and those outside the education system. In addition, it was among the few studies that did explore women-paternal endorsement and how parental approval of the vaccine influenced young adult women’s decisions about HPV vaccine uptake. The data used in the study were collected almost 10 years ago, so the associations between and among the variables might have changed. Even though the researchers provided vouchers

for free vaccines, they did not assess the degree to which the recipients' interactive and critical HL levels could have impacted their ability to act on the voucher, as explained by Nutbeam's (2000) HL model.

In an anonymous web-based survey, Marchand et al. (2012) used the health behavioral framework as their theoretical foundation and skip logic to administer surveys to 178 young adult community college students in Los Angeles ages 18 to 26 years. The participants were 32% African Americans and 59% Hispanic Americans. The purpose of the study was to determine whether social norms and health care (i.e., health care providers' recommendations) variables were associated with HPV vaccine initiation. Although 79% of the participants reported knowing about HPV, 30% had not heard of or did not know about the HPV vaccine (Marchand et al., 2012). Bivariate comparisons using chi-square and *t*-test analyses showed that health care providers' recommendations, perceived safety concerns of the vaccine, health care utilization, and social approval were significant predictors of HPV vaccine uptake. A multivariate logistic regression identified younger age and health-related majors in school as significant predictors of HPV vaccine uptake among college students (Marchand et al., 2012). Recruitment was restricted to college students, so the findings could not be generalized.

Using purposive sampling, Yi et al. (2013) recruited 95 Vietnamese American women with a mean age 48.9 (SD = ±7.3) year, from a large Vietnamese shopping center in Houston to describe and assess the women's HPV knowledge and HPV vaccination intentions for their daughters. All of the participants were born in Vietnam, had lived in the United States for an average of 18.2 years, and had daughters between the ages of 9

and 26 years. The survey was translated into Vietnamese, and the translated version was reviewed by the native speakers of Vietnamese who were on the research team. The translated survey was tested and approved by experts in the Vietnamese community. The researchers then conducted face-to-face interviews in either English or Vietnamese, depending on the participants' language preference. Two trained bicultural and bilingual female staff conducted the interviews.

Of the 95 participants, 28% reported proficiency in English speaking, 29% in reading, 22% in writing, and 32% in understanding spoken English very well. Data analysis revealed that 45% of the respondents reported having adequate knowledge of HPV. Yi et al. (2013) used a backward elimination multiple logic regression to enter the possible predictors into a model to determine the probability of the participants' HPV knowledge to predict their awareness of the vaccine. Results of the multivariate logistic regression identified English proficiency (speaking, understanding, and writing); higher education; health insurance; and affordability of the HPV vaccine as significant predictors of HPV awareness (Yi et al., 2013). Among the participants with inadequate knowledge of the virus, 86% reported their intention to vaccinate their children upon recommendations made by their health care providers. The lack of strong validity and reliability of the translated survey and the lack of a theoretical framework in Yi et al.'s study affected the generalizability of the results. Nevertheless, the results did show that the functional HL of parents can have a huge impact on young adult women, some of whom might depend on parental recommendations to get the vaccine.

Head and Harsin (2016) reported that the vaccine recommendation made by mothers is a strong subjective normative predictor for vaccine intent among young adult women. Yi et al.'s (2013) results demonstrated that young women whose mothers had limited education, no health insurance, and little proficiency in English might not have made any recommendations for the vaccine.

Massad et al. (2015) assessed young adult women's knowledge of HPV, cervical cancer prevention, and HPV vaccination. In this multicenter prospective cohort study involving 974 mostly low-income minority women at six study consortia, that is, the Bronx; Brooklyn; Chicago; Los Angeles; San Francisco; and Washington, DC, the researchers asked the participants to complete a 44-item, self-administered questionnaire on the variables of interest in 2007, 2008 to 2009, and 2011. A paired *t*-test analysis of the data showed a significant increase in overall knowledge of HPV and HPV vaccine between 2007 and 2011. The mean knowledge scores for 2007, 2008 to 2009, and 2011were 12.8, 13.9, and 14.9, respectively. Despite the significant increase in knowledge among the participants, Massad et al. found substantial gaps in the participants' understanding of the link between HPV and cervical cancer prevention. Results also confirmed Strohl et al.'s (2015) findings that income and education level are among the factors that can affect HPV, cervical cancer, and HPV vaccine knowledge. Massad et al. recommended further studies to explore the determinants of prevention behaviors and identify factors for early cervical cancer detection.

Between November 2007 and January 2009, Patel et al. (2012) recruited 256 unvaccinated young college women, ages 18 to 26 years, from a gynecological health

care clinic at the University of Michigan to examine two key variables: intent to receive HPV vaccine and effect of an educational intervention. More than 67% of the participants were European Americans, and they were randomly placed into either the intervention group or the control group using preassigned computer-generated numbers. Patel et al. used the TPB and asked a single question to assess participants' intention to get the HPV vaccine within 6 months of the enrollment date. Of the 256 respondents, 84.4% were single, 70.7% were undergraduates, and 48.9% reported having between two and five lifetime sexual partners. The researchers dichotomized the outcome variable (i.e., intention to vaccinate) and used logistic regression to analyze the data. The 41% of participants who intended to receive the vaccine cited concerns about cervical cancer, HPV, and physicians' recommendation as the reasons to vaccinate. Thus, perceived susceptibility and subjective norms (i.e., parents, physicians, and religious bodies) significantly predicted their intention to vaccinate. Concerns about vaccine safety, high cost of the vaccine, side effects, and uncertainty were among the reasons that influenced other students not to be vaccinated. Individuals with the intention to vaccinate (at baseline) were10 times more likely to receive the vaccine within 6 months (Patel et al., 2009).

Results confirmed the TPB assumption that intention is antecedent to behavior and also identified variables that could influence intention to vaccinate. Patel et al. (2012), however, did not include sufficient percentages racial minority women to assess the marginalized population's vaccine intent and uptake adequately: Only 9% of the participants were African American women, and 4.7% were Hispanic American women.

The small number of participants who received the vaccine did not allow the researchers to evaluate the factors that motivated the individuals to move beyond intention.

Using a sequential, explanatory mixed method design, Luque et al. (2012) used the social marketing conceptual framework to conduct a formative study to identify environmental factors influencing HPV vaccine uptake among low-income Latina farm workers in central Florida. The researchers used purposive sampling to recruit 40 patients ages 18 to 55 years with no history of cervical cancer from two health care clinics. Trained and qualified interviewers used a structured interview protocol and followed a structured questionnaire to obtain responses from the 40 participants. Luque et al. also recruited six other participants (five Mexicans and one Guatemalan) as key informants who shared information regarding perceived barriers and benefits as part of the qualitative aspect of the study. A trained bilingual interviewer interviewed key informants (i.e., community leaders and health care providers who had community-level knowledge of health care issues in the community) in a room adjacent to the clinic.

Two independent reviewers, using thematic analysis approach with an interrater reliability coefficient of 0.80, analyzed the qualitative data and then grouped the responses by perceived barriers and benefits, promotions related to HPV vaccine, place, and cost (Luque et al., 2012). In addition to low HPV and HPV vaccine knowledge and awareness, the factors that influenced vaccine uptake included access to health care, lack of health insurance, inadequate information and recommendations from health care providers, language barriers, concerns about promiscuity, misconceptions about the vaccine, and transportation to the site of the vaccine. The preventive benefits of the

vaccine, the potential to save numerous lives, and the desire to maintain good health were among the perceived benefits (Luque et al., 2012).

The limitations of this study included the smaller sample size and the narrow focus on only Latinas from Mexico and Honduras. Luque et al. (2012), however, identified certain structural barriers and perceived benefits that might help to explain the population's reason for not accepting the vaccine. Results provided a platform that future studies could build on to increase the HPV vaccine uptake among Latinas.

In another mixed method design, Joseph et al. (2014) used the HBM constructs and grounded theory to identify factors that could facilitate or hinder HPV vaccine acceptability among low-income minority young adult women ages 18 to 22 years. Their mean age was 19 years. The researchers recruited 132 participants, mostly Latina and Haitian immigrants, from an urban academic medical center and two community health centers. The participants had to speak at least one of the following languages: English, Spanish, or Haitian Creole. Recruitment for this longitudinal study occurred in the pediatric and adolescent departments of the identified sites between July 2007 and January 2009.

Joseph et al. (2014) gathered survey data and assessed participants' knowledge of HPV and HPV vaccine, level of trust in health care providers, and vaccination intention on a 4-point Likert scale. The qualitative portion of the measurement involved the application of four constructs of the HBM (perceived severity, perceived susceptibility, perceived benefits, and perceived barriers) in semistructured interviews. Joseph et al. wanted to understand the respondents' perceptions (i.e., attitudes and beliefs) that might

have hindered their acceptance of the HPV vaccine. The researchers reviewed the medical records of the participants at 12 months and 5 years from study enrollment to assess the relationship between intention to vaccinate and actual vaccination. The continuous and categorical data from the quantitative measurement were analyzed using *t* tests and chi-square tests, respectively. Joseph et al. reviewed the questionnaire responses; coded them into themes; and examined their relationships to vaccination intention, ethnicity, and HPV vaccine uptake. The quantitative results revealed that 94% of the participants trusted the physicians' recommendations for the vaccine. All of the European American participants, compared to 87% and 85% of the African American and Latina American participants, respectively, reported knowing about HPV infection (Joseph et al., 2014). Marital status significantly predicted intention of getting the HPV vaccine, and physicians' recommendation predicted receipt of the HPV vaccine.

Joseph et al. (2014) noted in their results that inadequate knowledge about the virus and the vaccine, fear of promiscuity, perceived low risk, and cost of the vaccine contributed to low vaccination uptake. Benefits of the vaccine included the life-saving potential and physicians' recommendations. Nearly 90% of the respondents expressed a positive attitude toward HPV vaccination before sexual debut, and the majority of them supported mandating the vaccine. In comparison to the European American and African American women, the Latina American participants reported engaging in limited parent-daughter and physician-patient discussions of sexual behavior. Results identified a disconnection between vaccine intention and vaccine initiation: Of the 90% of respondents who expressed their intent to vaccinate, only 51% actually initiated the

vaccine. Among the adolescents who initiated the vaccine, 78% completed all three HPV doses over 5 years (Joseph et al., 2014).

Joseph et al. (2014) identified the barriers and perceived benefits of the HPV vaccine and also highlighted the disconnection between vaccine intent and initiation. The selection criterion of age excluded individuals between the ages of 23 and 26 years who might have had different perceptions of the vaccine's barriers and benefits. The review of the medical records served as a triangulation method to reduce reporting bias; however, this study could have been impacted by selection bias because only individuals who visited the clinics between July 2007 and January 2009 were eligible to be in the study. Use of the IBM could have helped to identify the factors that could have motivated the individuals to act on their intentions.

In a cross-sectional study involving 1,467 African American adults from the Houston metropolitan area, Hoover et al. (2015) examined secondary data from a longitudinal cohort study (Project CHURCH) to assess the association between HL and indicators of poor physical or mental health. The sample of convenience comprised 74.6% female and 25.4% male participants. Their mean age was 45.19 years (ranging from 18-86 years); 35% reported annual household incomes of less than $50,000, and approximately 49% of the participants had at least a college degree. Hoover et al. used a single item-questionnaire comparable to the Rapid Estimate Adults Literacy in Medicine (REALM) and Short Test of Functional Health Literacy in Adults (STOFHLA) to assess participants' levels of HL. Of the 1,467 participants, nearly 19% demonstrated low levels of HL (Hoover et al., 2015).

A multiple logistic regression analysis of the data revealed a significant association between low levels of HL and the variables of smoking, poor physical health, and poor mental health. Low levels of HL independently predict perceived stress and depressive symptoms, and they are a significant predictor of poor health among African American adults. The study demonstrated how low levels of HL elucidated multiple health risk factors. Thus, the 24% and 41% of the African American and Hispanic American population, respectively, identified by Daniel-Ulloa (2016) as having low HL levels were at risk for risky health behaviors (Hoover et al., 2015; Kutner et al., 2006). Hoover et al. (2015), however, looked only at functional HL without considering other factors that can motivate individuals to act on their behavioral intentions.

In a correlational, cross-sectional study, Cha et al. (2014) used convenience sampling to recruit 106 mostly African American participants who were overweight or obese young adults. They ranged in age from 18 to 29 years (M = 23.99 years) and were from the Atlanta metropolitan area. The sample comprised 81 women and 22 men; 82.5% had at least some college education; and 22.3%, 31.1%, and 46.6% were overweight, moderately obese, or morbidly obese, respectively (Cha et al., 2014). The researchers excluded participants with confirmed diagnoses of diabetes or other diseases that could have influenced the A1C test. The participants provided information on all of the variables of interest.

Cha et al. (2014) used aspects of the TTM transtheoretical model to examine the relations among HL, self-efficacy, and dietary quality. The participants' levels of HL regarding food labels were assessed using the Newest Vital Sign (NVS) Scale (numeracy,

basic literacy, and document literacy); they were categorized as low, medium, or high levels of HL. The path analysis showed that the African American participants significantly had low levels of HL, less basic education, and higher body mass index numbers. The analysis further showed that participants with low levels of HL were less likely than those with high levels of HL to use food labels. Low levels of HL also had a significant association with low dietary quality, and self-efficacy and low levels of HL positively predicted food label use behavior and dietary quality (Cha et al., 2014). The researchers recommended that future studies be conducted to identify ways to increase levels of HL to improve health behaviors. Results demonstrated the clear relationship between low levels of HL and poor health behaviors among young adults. Findings could not be generalized because of the small sample size, the convenience sampling design, and the small geographic area that the researchers recruited from.

Britt et al. (2015) conducted a study of 396 college students, ages 18 to 43 years attending a large Midwestern university to assess the relationship between eHealth literacy and the factors influencing the students' intention to accept HPV vaccination. They found a positive association between the IVs of attitude, subjective norms, and perceived behavioral control and the DV of HPV vaccine intention. The participants were predominantly European American students (82.8%); the mean age of the sample was 20.3 years. Of the 396 participants, 219 had not initiated the HPV vaccine, and 149 had received at least one dose of the vaccine. Their eHealth literacy was measured using eHEALS, a validated eight-item instrument (Cronbach's alpha of 0.93), on a 5-point Likert scale. Each IV was measured on a 7-point Likert scale with adequate reliability,

Cronbach's alpha ranging from 0.80 to 0.85. A correlation analysis showed a positive association between HPV vaccination intention and perceived control with eHealth. A hierarchical multiple regression indicated that perceived behavioral control mediated the relationship between eHealth literacy and vaccination intent (Britt et al., 2015). The researchers recommended future explorations of the influence of eHealth literacy and HPV vaccination belief on vaccination uptake to understand and promote healthy preventive behaviors. Results showed that the behavioral intent of the participants was mediated by the three major constructs of the TPB: attitude, normative beliefs, and perceived control. However, the sample did not include enough African American and Hispanic American women, who represented only 3.2% and 3.4%, respectively, of the sample, so the results cannot be generalized to all marginalized women.

Literature Related to Methodology

Apolinario, Mansur, Carthery-Goulart, Brucki, and Nitrini (2015) explored the relationship between functional HL and cognitive abilities. They found a strong association between HL and cognitive performance among the 322 participants, all of whom came from heterogeneous SES backgrounds in Brazil. Using convenient sampling, the researchers recruited patients from public hospitals in Sao Paulo who were 18 years of age or older and had a mean age of 47.2 years and an average educational attainment of 9.6 years. The researchers collected demographic information through interviews and assessed the participants' cognitive performances in global functions, learning, and visuospatial skills using previously validated instruments. The instruments used were the Mini-Mental Status Examination, the Brief Cognitive Battery, the Clock Drawing Test,

and the STOFHLA (Apolinario et al., 2015). Descriptive statistics showed that 90.5% of the participants with less than 4 years of formal education had inadequate levels of HL and that only 44.5% of the young adults ages 18 to 39 years demonstrated adequate levels of HL (Apolinario et al., 2015). A binary logistic regression revealed a significant association between limited HL and poor cognitive performance.

Apolinario et al. (2015) tested different variables (i.e., functional, interactive, and critical HL) that could have influenced the participants' capability of acquiring and processing health information. Results could have been impacted by selection bias, so they could not be generalized. The sample included older individuals, some of them might have been suffering from undiagnosed neurodegenerative diseases that could have affected the cognitive results.

A multicenter prospective longitudinal cohort study in Germany by A. Schmidt et al. (2015) assessed the effect of HL on information needs among women newly diagnosed with breast cancer to test the hypothesis that level of HL determines patients' information needs. The primary objective of A. Schmidt et al.'s study was to determine the appropriate HL training measures that would be needed to provide information to support newly diagnosed breast cancer patients. The researchers recruited 1,359 women newly diagnosed with breast cancer from 60 hospitals (with 54 breast centers) between February and August 2013. All the participants were 18 years of age or older; 66% were married, 70.2% lived with partners, 39.3% were employed, and 28.3% had college or vocational diplomas.

A. Schmidt et al. (2015) used a modified 33-item questionnaire from the Cancer Patients Information Needs Scale in focus-group interviews to gather data. Participants' levels of HL were calculated using the Measurement of Health Literacy in Europe scale (A. Schmidt et al., 2015). A multivariate logistic regression showed that participants with low (43.4%) or intermediate (32.1%) levels of education were less likely than the participants with a college education to request information about supplementary naturopathy and physical burden, respectively. The analysis also revealed an inverse relationship between the participants' levels of HL and their unmet health information needs (A. Schmidt et al., 2015).

A. Schmidt et al. (2015) focused on the participants' ability to access, understand, and use health information to determine their levels of HL. Thus, the researchers operationalized HL (access, knowledge, and utilization) and identified its relationship to decision-making capabilities. Despite the strength of A. Schmidt et al.'s study, only 0.3% of the participants were between the ages of 20 and 30 years, so the findings cannot be generalized to young adult women. Future researchers should attempt to use the similar operationalized definition of HL with a greater focus on young adult women.

In a multinational cross-sectional study, Lupattelli, Picinardi, Einarson, and Nordeng (2014) recruited 4,999 pregnant women from 18 countries to explore the influence of HL on their perceptions of teratogenic risks and beliefs about medication. They also assessed the mediation effect that perceived medication risks and beliefs had on levels of HL and nonadherence behaviors during pregnancy. Of the 4,999 enrollees, 56% were between 20 and 30 years of age, 38% were between 31 and 40 years of age,

and the majority were recruited from Western countries and South American countries. Lupattelli et al. assessed the participants' levels of HL using a set of brief screening questions and trichotomized the results into low, medium, and high levels of literacy. The original questionnaire, which was in English and Norwegian, was later translated into other languages relevant to the participants. Data were collected between October 2011 and February 2012 using an anonymous Internet-based questionnaire. A multivariate logistic regression analysis of the data revealed a significant association between low levels of HL and the variables of flu vaccine nonadherence, maternal health behavior, and higher medications perception risk. Results highlighted the need to address HL as a major component of health promotion and adherence to healthy behaviors (Lupattelli et al., 2014).

Before 2009, HL levels were assessed using validated instruments such as the NVS, REALM, and TOFHLA. Each instrument depends on questionnaires to assess levels of HL accurately. None of the instruments can measure HLs level at the community or population level, and none of them can be applied to extant data to measure retrospectively the HL levels of the people being surveyed.

This limitation of the validated instruments prompted Martin et al. (2009) to apply linear and logistic regression analyses to National Assessment of Adult Literacy (NAAL) data from 2003 to determine mean HL scores and the likelihood of individuals having adequate levels of HL (i.e. proficiency above the basic level). The knowledge gained from Martin et al.'s study was further explored to develop predictive HL models using population-level existing data (Martin et al., 2009). Martin et al. demonstrated the ways

that multiple sociodemographic variables (i.e., gender, age, ethnicity, income, and education) could predict the probability of having adequate levels of HL. These predictive models were based on the results of analyzing the sociodemographic data obtained from 17,446 adults 18 years of age and older from the 2003 NAAL, and the results from the predictive models were similar to the NAAL's findings. The proposed models will allow researchers to use existing administrative or U.S. Census data to estimate individual and community levels of HL.

Although the validated predicted models are quite recent, Rasu, Bawa, Suminski, Snella, and Warady (2015) applied Martin et al.'s (2009) models on the 2005 to 2008 Medical Expenditure Panel Survey (MEPS) data, a nationally representative sample, to assess the impact of levels of HL on health care utilization and expenditure. The MEPS data were obtained from 22,599 participants, primarily European Americans, who had a mean age of 49 (SD = ±17.8) years. Rasu et al. concluded that individuals with basic or below-basic levels of HL had relatively more physician visits and spent more on health care than adults with adequate or above-basic levels of HL

In a separate retrospective cohort study, Bailey et al. (2015) validated Martin et al.'s (2009) proxy HL models against the three most commonly used validated HL assessment instruments: TOFHLA, REALM, and NVS. The researchers estimated the participants' levels of HL using sociodemographic information from an existing data set, Health Literacy and Cognitive Function among Older Adults (LitCog), and directly assessed their HL levels using the traditional assessment instruments (i.e., TOFHLA, REALM, and NVS). Upon comparing the HL results, Bailey et al. concluded that there

was a fair agreement between the HL derived from the secondary data and the in-person assessments. Results provided further validity and precision to the predictive HL model.

The NHIS is a nationally representative survey that does not directly measure individual levels of HL. The validated predictive models can be applied to the data from the multistage sampling design to estimate mean HL scores and the probability of individuals with specific sociodemographic characteristics having adequate (i.e., intermediate or proficient) levels of HL.

Literature Related to Content and Methodology

Using data sets from the 2008-2012 NHIS, A. Schmidt et al. (2015) investigated the HPV vaccination interests and nonvaccination reasons of 10,513 young adult women, ages 18 to 26 years who were living in the United States at the time of the study. The composition of the sample was 60% European American, 18% African American, and 15.5% Hispanics American participants; approximately 24% of the women did not have health insurance, 25% were below the federal poverty level (FPL) threshold, and more than 40% reported high school diplomas as their highest educational attainment. Of the 10,513 participants, approximately 23% reported receiving at least one dose of the HPV vaccine. Participants without health insurance, those with no specific place to receive regular care, and those who had received recommendations for the vaccine were more likely to express HPV vaccine interest and intention.

A. Schmidt et al. (2015) identified lack of vaccine information, inadequate disease knowledge, and concern about vaccine safety as the main reasons for not receiving the vaccine. Approximately 35% of the unvaccinated respondents expressed an interest in

receiving the vaccine, but the lack of knowledge and environmental factors such as inaccessibility to the vaccine and spousal objection prevented the women from acting on their intentions to perform the healthy behavior (A. Schmidt et al., 2015).

In a similar study, Price et al. (2011) examined NHIS data from 2008 to assess HPV vaccine awareness and identify reasons for not receiving the vaccine. The completed statistical analysis of the data from the sample of 1,583 young adult women ages 18 to 26 years. Of the 1,583 participants, 24.5% had no health insurance, 14.3% had not seen a physician or an obstetrician in the past 12 months, 16% reported no receipt of any the recommended lifetime vaccines, and 83% had not received an influenza shot or nasal spray in the past year (Price et al., 2011). Overall, 11.7% of the young adult female participants reported receiving at least one dose of the HPV vaccine.

A multivariable logistic regression showed that the young adult women without health insurance were 86% less likely than participants with private health insurance to initiate HPV vaccination. Participants who did not visit a physician or had an obstetrician visit in the past year were 43% less likely to initiate the HPV vaccine. Respondents who reported no receipt of the recommended vaccine had ORs of 0.32 (95% confidence interval [CI], 0.13, 0.77) to receive HPV vaccine (Price et al., 2011).

Price et al. (2011) also found significant HPV vaccine awareness among respondents with private health insurance as well as those who had used the health care system (i.e., provider visits or receipt of at least one of the recommended lifetime vaccines) within the past 12 months. Unvaccinated respondents identified safety concerns about the vaccine, no recommendations from health care providers to have the vaccine,

lack of vaccine knowledge and awareness, no sexual activity, and expensive cost of the vaccine. Among the unvaccinated respondents who reported an unwillingness to pay the full cost of $500 for the vaccine, 98% expressed their willingness to receive the vaccine at a greatly reduced cost. Although Price et al. provided valuable information for public health practitioners about actual HPV vaccine uptake intention, they did not combine the sociodemographic characters on the respondents to assess the effect of levels of HL on vaccine uptake.

In a primary study, Strohl et al. (2015) used convenience sampling to assess the knowledge of HPV, cervical cancer, and HPV vaccination of 215 African American women ages 18 to 70 years who were living in Chicago at the time of the study. In this cross-sectional study, the participants were surveyed using the Awareness of HPV and Cervical Cancer Questionnaire, a validated, self-administered tool developed by Ingledue et al. in 2004 to assess the knowledge and beliefs on HPV and cervical cancer (as cited in Strohl et al., 2015). Of the 28 items to assess knowledge, Strohl et al. categorized a cumulative HPV knowledge score of 18 or more correct answers as adequate knowledge; however, 73% of the participants failed to demonstrate adequate knowledge of HPV and cervical cancer. Strohl et al. identified household income and level of education as two factors that were positively associated with HPV knowledge. Results pointed to the need to increase knowledge of HPV, cervical cancer, and HPV vaccination among adult African American women to improve HPV vaccine uptake rates. As Kobetz, Kornfeld, Vanderpool, and Rutten (2013) asserted, knowledge is an important determinant of health behavior. Low knowledge of HPV, cervical cancer, and HPV vaccine among adult

Hispanic American and African American women negatively affected their HPV vaccine uptake rates.

The 2013 NCI Health Information National Trend Survey (HINTS) Iteration 4, Cycle 3, which contained data on respondents' knowledge and awareness on HPV was analyzed by Blake et al. (2015) to assess population awareness and knowledge of HPV and the HPV vaccine. In a cross-sectional study design, Blake et al. used data from the HINTS 4, Cycle 3 to assess how sociodemographic factors, namely, age, ethnicity, SES, and geographical area, contribute to gaps in HPV awareness and knowledge. Blake et al. (2015) statistically analyzed data from 3,185 participants (equal number of men and women) ages 18 years or older; 78.3% of the participants were European American, and 12.9% were African American; 82.1% resided in urban areas, and 17.9% lived in rural areas. A total of 66.8% reported their highest educational attainment as technical, vocational, or college degree, and 67% had total annual household incomes of less than $75,000 (Blake et al., 2015).

A multivariate logistic regression that used listwise deletion for case analysis showed that the African American (57%) and Multiracial (60%) group of participants in the sample were less likely than the European American participants to identify HPV as a sexually transmitted disease. Gender, age group, location (rural vs. urban), and highest educational level significantly predicted the ability to identify HPV as a sexually transmitted disease (Blake et al., 2015). Thus, the female and male respondents between the ages of 18 and 34 years were more likely to know about HPV and the HPV vaccine.

Regarding HPV and HPV vaccine knowledge, the men were 75% less likely than the women to know about them, respondents with a high school diploma were 45% less likely than those with a college degree to know, and those without access to the Internet were 32% less likely to have heard of the vaccine (Blake et al., 2015). Even though HPV is transmitted sexually, the result indicated that the men were significantly less aware of the vaccine for prevention, highlighting the need to include male participants in any educational promotion program. Results also indicated that disparities in HPV and HPV vaccine knowledge were closely associated with sociodemographic factors. Public health practitioners need to take those factors into account when designing health promotion programs. Blake et al. did not stratify the age groups to analyze the data separately for the young adults (18-26 years). Not all participants in the 18- to -34-year group qualified for the booster vaccine, so it would be difficult to base a health promotion program on this result to target young adults when planning a health promotion program for HPV vaccine uptake.

A secondary analysis of Project Re-Engineered Discharge and RED-Lit clinical trial data sets at the Boston Medical Center by Mitchell, Sadikova, Jack, and Paasche-Orlow (2012) revealed that low levels of HL significantly predicted hospital reutilization (i.e., readmission or emergency room visit). Mitchell et al. examined the relationship between HL levels and the return of patients to the hospital within a month of discharge. They hypothesized that low levels of HL were a risk factor for hospital reutilization.

Mitchell et al. (2012) used data from 703 patients from the control group of the Project RED-Lit trial who were 18 years of age or older (M = 51.23 years). Of the 703

control patients, 369 were African American, and 78 were Hispanic American participants. Patients' levels of HL were measured using the validated 66-item instrument REALM, and hospital reutilization was assessed by reviewing the medical records at the center and neighboring hospitals. Of the total participants, 20% had low levels of HL, 29% had marginal levels of HL, and 51% had adequate levels of HL. Patients with low levels of HL were more likely to be African Americans, less educated, and from low-SES backgrounds (Mitchell et al., 2012).

A multivariate Poisson regression analysis of the adjusted incidence rate ratio showed that patients with low levels of HL were 46% more likely to return to hospital within a month of discharge. In addition, 71% and 67% of the participants with low levels of HL were more likely patients with adequate HL to be readmitted to the emergency room or the hospital within a month (Mitchell et al., 2012). This study only measured the functional HL of the participants. It did not stratify the data by age to identify any modification effect. Despite the limitations, Mitchell et al. (2012) demonstrated that low HL is associated with sociodemographic factors and can modulate the effect of physicians' recommendations to patients.

Researchers using a stratified retrospective cohort case-control study in Israel reported that parents' higher levels of communicative and critical HL significantly attenuated vaccine compliance for their children (Aharon, Nehama, Rishpon, & Baron-Epel, 2017). The researchers recruited 309 parents of children who had not completed at least one of the core vaccination protocols before the age of 2 years and assigned them to the study group. Another 422 parents whose children had completed the core vaccination

protocols became the control group. The investigators drew from the Paasche-Orlow and Wolf (2007) and Nutbeam (2000) models, both of which assumed a direct association between HL level and vaccination compliance, and they used the mediating effects of knowledge, attitudes, and beliefs as the conceptual framework.

Aharon et al. (2017) used Ishikawa, Takeuchi, and Yano's (2008) 13-item questionnaire to measure the participants' functional, communicative, and critical HL levels. Assessment of the participants' knowledge, belief, and attitudes was performed using Salmon et al.'s (2004) instrument (Aharon et al., 2017). Chi-square, ANOVA, and MANOVA analyses showed that the parents in the control group had significantly lower income and educational levels than those in the study group. The path analysis of the data revealed an inverse relationship between functional levels of HL and provaccine attitudes. Higher critical levels of HL corresponded significantly to higher antivaccine attitudes, and communicative levels of HL were directly associated with vaccine completion (Aharon et al., 2017).

Without using any specified theoretical framework, Kobetz et al. (2013) conducted a cross-sectional study of secondary data from the 2007 HINTS to examine the knowledge and awareness of 375 Hispanic American women regarding HPV vaccine acceptability. Data analysis revealed high HPV awareness among participants ages 18 to 44 years, but the same participants had low knowledge of HPV infection and cancer (Kobetz et al., 2013). Despite potential bias being introduced by convenient sampling and the smaller sample size, Kobetz et al. concluded that the women's limited knowledge of the cervical cancer-causing virus influenced their HPV vaccine uptake. The researchers

recommended that public health practitioners disaggregate and focus on individuals with limited knowledge because knowledge is an important determinant of health behavior.

Literature Review Synthesis on Health Literacy

A significant association between low and marginal levels of HL and poor health outcomes has been found. However, the focus of most HL studies has been on older adults, individuals with less than a high school diploma, people with low SES, and non-English speakers (Institute of Medicine [IOM], 2004). Individuals between the ages of 18 and 26 years are usually considered college age and able to read and write (general literacy), which places them outside the at-risk group (Sørensen et al., 2012). Wallace, Rogers, Roskos, Holiday, and Weiss (2006) posited that the use of income and highest educational attainment as proxies for HL levels overestimate actual HL levels. A secondary data analysis of a longitudinal study in the Houston metropolitan area showed that approximately 20% of the participants had inadequate levels of HL, even though approximately 49% and 62% had a college degree and more than $50,000 in household income, respectively, per year (Hoover et al., 2015). As part of a prospective cohort study in Germany involving 1,344 participants, A. Schmidt et al. (2015) demonstrated that individuals with low or intermediate levels of HL were less likely to seek health-related information. A. Schmidt et al. concluded that the factors influencing unmet informational needs can include HL, sociodemographic characteristics, and employment status. Thus, inadequate levels of HL might be a modifiable risk factor for certain unhealthy behaviors (Hoover et al., 2015; Mitchell et al., 2012), whereas adequate levels of HL can have a positive influence on health information sources and health beliefs (Kim, Lim, & Park,

2015). Social capital (i.e., bonding with people who have adequate levels of HL or are living in communities with high community-level HL) can attenuate the effect of low functional levels of HL on health behavior. Public health practitioners might need to look into ways to improve the social capital of young adults by examining parent-child relationships that persist and inform health behaviors during young adulthood (Johnson, Giordano, Manning, & Longmore, 2011).

Low knowledge about HPV and HPV vaccine, vaccine safety, concern about promiscuity, vaccine cost, inadequate social normative factors, perceived harm, and environmental barriers are among the reasons for low HPV vaccine uptake rates (Ratanasiripong et al., 2013; Ziemer & Hoffman, 2013). The increase in HPV knowledge and intention to vaccinate have not resulted in higher HPV vaccine uptake rates (Casey et al., 2013; Spleen, Kluhsman, Clark, Dignan, & Lengerich, 2012). The literature has identified the role of normative and subjective norms, including recommendations from physicians, maternal recommendation for the vaccine, and father-daughter relationships, in improving HPV vaccine uptake (Bennett, Buchanan, & Adams, 2012; Casey et al., 2013; Head & Harsin, 2016). Unfortunately, racial minorities are less likely to receive physician recommendations for the HPV vaccine (Jeudin, Liveright, Del Carmen, & Perkins, 2014; Ylitalo, Lee, & Mehta, 2013).

Besides recommendations from physicians, young adult women who might have limited knowledge of gynecological health might look to their parents for advice on the vaccine. Parents in underserved communities who have limited education and knowledge of HPV and HPV vaccine, might depend on physicians or opinion leaders to address their

concerns about vaccine safety and efficacy. Physicians are less likely to discuss the HPV vaccine with Hispanic American and African American parents, people with no college education, and those 35 years of age and older (Ojinnaka et al., 2017; Savas, Fernández, Jobe, & Carmack, 2012).

The lack of physician recommendations becomes compounded when combined with the lack of knowledge of HPV and HPV vaccine; the absence of social capital to mediate the effects low HL; and environmental barriers such as transportation, vaccine cost, and navigation through the complex health care system. Moreover, SES factors such as education, income, and employment hinder access to health information and the ability to act on acquired information to make health-related decisions. According to Blake et al. (2015), sociodemographic characteristics can contribute significantly to HPV awareness and knowledge.

The Affordable Care Act of 2010 defined HL as "the degree to which an individual can obtain, communicate, process, and understand health information and services in order to make appropriate health decisions" (as cited in Somers & Mahadevan, 2010, p. 7). Health knowledge is a major component in the ability to obtain and process health information. A cross-sectional study that conveniently recruited 242 African American women in Chicago concluded that African American and Hispanic American women had low knowledge of HPV and the HPV vaccine (Strohl et al., 2015). A different cross-sectional study that analyzed data from the HINTS database in Florida on Latina American women confirmed similar results, noting that Latina American also had low knowledge of HPV and the HPV vaccine (Kobetz et al., 2013). Based on this

literature review, I sought to examine the relationship between derived HL (calculated from sociodemographic characteristics) and HPV vaccine uptake among young African American and Hispanic American women between ages 18 and 26 years.

Theoretical Basis of the Integrated Health Model

Branscum and Lora (2016) developed and validated an instrument based on the IBM to evaluate the ways that low-income Hispanic American mothers in Oklahoma City, Oklahoma, with preschool children (ages 2-5 years) monitored the obesogenic behaviors (fruits and vegetables, and sugar-sweetened beverages) of their children. The researchers conducted nine focus group meetings involving 20 semistructured interviews in Spanish with the 238 mothers in the sample. Their mean age was 33.1 (± 6.4) years. The researchers established face and content validity through a six-member expert panel review. Of the 238 participants, 42% were obese, 92% were immigrants, 73% had high school or less as their highest educational attainment, and more than 50% were unemployed (Branscum & Lora, 2016). The psychometric instrument had Cronbach's alpha scores ranging from 0.41 (autonomy) to 0.94 (intentions). Thus, the internal consistency of reliability of the autonomy scale was considered unacceptable; all other Cronbach's alphas, intentions, normative beliefs, and perceived power or control beliefs, were deemed acceptable (> 0.70). Results showed that the IBM provided internal consistency and validity when measuring determinants of behavior intention as well as motivational factors influencing individuals to act on the intention.

In a qualitative study guided by the IBM, Mills, Head, and Vanderpool (2013) recruited 17 young adult women, ages 18 to 26 years from a federally qualified health

center (FQHC) in Appalachian Kentucky. Mills et al. reviewed the medical charts of these underserved patients seen at the FQHC between March 2008 and September 2009, a period when the center offered free HPV vaccines to all eligible patients, to selectively recruit women who had either declined or failed to complete the HPV vaccine doses. All participants were European American women. Fifteen had no health insurance; nine initiated the vaccine, but did not complete the series; and eight declined the vaccine. The participants were interviewed over the telephone, and the researchers used an iterative process to analyze the interview transcriptions. Analysis of the data revealed similar knowledge (misinformed and uninformed) about HPV vaccine and cervical cancer

Mills et al. (2013) identified three variables that impacted HPV vaccine initiation: knowledge gap, environmental barriers, and socionormative barriers. All of these variables were antecedent to intention to perform a behavior (Mills et al., 2013). Knowledge gap, social and normative factors, and environmental barriers were among factors that influenced HL. The focus of Mills et al.'s study, however, was not on HL, unlike other studies that had sought to assess the relationships between HL and HPV vaccine uptake (Australian Commission of Safety and Quality in Health Care, 2014; Clark, 2009; George, Hayes, Fish, Daskivich, & Ogunyemi, 2016; Patel et al., 2012).

Cohen and Head (2014) conducted a similar study and investigated the influence of parental knowledge, behavioral beliefs, attitudes, normative social beliefs, and environmental barriers on vaccination acceptance for their children. In this formative research, the investigators recruited 20 mothers (mean age 40.4 years) who were responsible for making vaccination decision for adolescents between the ages of 11 and

18 years. The mothers were living in the Kentucky River-Area Development District, an eight-county area with low vaccination rates.

Cohen and Head (2014) used the IBM as the theoretical framework and conducted semistructured interviews to assess the participants' vaccination-related behaviors, knowledge, and attitudes regarding adolescents' vaccination. Each researcher analyzed the interview transcriptions independently to identify key ideas. They teamed up to code the data using the sequential inductive data analysis method.

Cohen and Head (2014) concluded that vaccination knowledge by itself did not relate strongly to parental decision-making behavior. Attitudes toward vaccination, on the other hand, were strong predictors of parental vaccination behavior for their adolescent children. Through the use of the IBM constructs, the researchers identified social normative influence as a significant motivator of vaccination behavior. The IBM in this study provided the conceptual framework to highlight behavioral determinants of vaccine acceptance. Results helped to address the knowledge-attitude-practice gap by showing that the knowledge-eccentric approach to improve vaccine uptake was not sufficient and that future researchers must consider preventive attitudes at the community or societal level.

From a reduction point of view, health literacy is solely responsible for determining the ability to acquire and act on health information. Such an approach, however, might be too restrictive and ineffective in health promotion intervention, and it also might not account for the SES, cultural, motivational, and environmental factors that interact to influence the ability to access, process, and apply health information. Thus, a

theoretical framework for health promotion intervention needs to focus not only on the targeted individuals but also the factors influencing interpersonal, societal, and environmental variables (Sallis, Owen, & Fisher, 2008).

Because HL levels are the result of the cumulative impact of SES and environmental factors, Ross, Culbert, Gasper, and Kimmey (2009) posited that adopting an ecological model to improve levels of HL in a health promotion intervention was a reasonable approach. The IBM can address behaviors at the individual level and apply constructs from other behavioral theories to address social, economic, and environmental variables at the ecological level. For instance, the personal agency constructs in the IBM are similar to the self-efficacy construct under the SCT that can form the core construct of the social ecological model—reciprocal determinism (Branscum & Lora, 2016; Sallis et al., 2008).

Summary

Studies that applied elements of the most acceptable behavioral theories namely TRA/TPB, HBM, SCT, TTM, and the IBM independently identified some factors that influence vaccine uptake and cancer prevention behaviors. Positive subjective normative influence from parents and health care providers, attitudes about the HPV vaccine, perceived control, perceived harm, and health knowledge are significant predictors of young adult women's vaccination intention (Casey et al., 2013; Head & Harsin, 2016; Ratanasiripong et al., 2013; Ziemer & Hoffman, 2013). Among the racial minority young adult women, there is a significant gap in knowledge regarding their understanding of the

link between HPV infection and cervical cancer prevention (Massad et al., 2015; Strohl et al., 2015).

Low health literacy level is significantly associated with untoward health outcomes (Aharon et al., 2017; Hoover et al., 2015; Mitchell et al., 2012). Individuals with low HL are less likely to adhere to health care instructions or seek for health care information, as compared to those with adequate HL levels (Lupattelli et al., 2014; Mitchell et al., 2012; Schmidt et al., 2015). Health literacy involves cognitive and social skills that are antecedent to behavior, and it has significant impact on HPV vaccine uptake among young adult women (Apolinario et al., 2015; Head & Harsin, 2016; Patel et al., 2012; World Health Organinization [WHO], 2017). The use of HL models developed by Martin et al. (2009) on sociodemographic variables to compute HLL show comparable agreement with directly measured HL levels (Bailey et al., 2015; Rasu et al., 2015).

Preview of the Chapter 3

To examine the relationships among the variables, I applied a quantitative method of research design on a publicly available cross-sectional secondary data from the 2015 NHIS, to answer the two RQs of the study.

Chapter 3: Research Method

Overview

Low and marginal levels of HL have been associated with untoward health outcomes (Aharon et al., 2017; Hoover et al., 2015; Mitchell et al., 2012). Such individuals have been found to be less likely to request helpful health information or adopt preventive health behaviors (Cha et al., 2014; A. Schmidt et al., 2015). The focus of most HL studies has been the at-risk group, that is, individuals from low SES backgrounds, older adults, and those with language barriers (IOM, 2004). Other studies have dwelt only on an individual's ability to apply basic literacy skills (reading and writing), without considering the person's interactive and critical levels of HL (Nutbeam, 2000).

Research on the relationship between HL and HPV vaccine uptake has been scant. Despite numerous recommendations made by researchers to consider HL a major component of health promotion, only limited research exist (Hoover et al., 2015; Howe, Cipher, LeFlore, & Lipman, 2015; Johri et al., 2015; Kim et al., 2015; Smith, Forster, & Kobayashi, 2015; Sun et al., 2013; Veldwijk et al., 2015). Recent research has shown that low and marginal levels of HL positively and independently relate to low adherence to preventive and protective health behaviors (Castro-Sanchez, Chang, Vila-Candel, Escobedo, & Holmes, 2016; Lee, Tsai, Tsai, & Kuo, 2012). Researchers also have suggested more focus on community-level HL by shifting the emphasis from individuals to the complex system that influences and shapes individuals' health behavior (Crosby, Kegler, & DiClemente, 2000; Nutbeam, 2000). According to Kim et al. (2015),

community-level HL provides the infrastructure to individual residents to acquire the health information and the social support necessary to make informed decisions.

I used secondary data to assess the relationship between levels of HL and HPV vaccine uptake among noninstitutionalized, civilian, racial minority women between the ages of 18 and 26 years, specifically African American and Hispanic American women who were living in the United States at the time of the study. The purpose of this secondary data analysis of NHIS files from 2015 was to test the IBM that relates HL to HPV vaccine uptake while controlling for age, SES, education, marital status, and English proficiency. HPV vaccine uptake (≥ 1 dose) was the DV; the IVs were ethnicity and HL.

Instrument to Measure Health Literacy

Before 2009, almost all measurements of levels of HL were based on primary data. In an attempt to employ current data to estimate a community's HL mean scores and predict the probability of individuals having adequate (i.e., above basic) HL levels, Martin et al. (2009) used the NAAL from 2003 to develop two predictive models. The HL model involved 17,446 adults (18 years of age or older) residing in the United States. The NAAL used a scale ranging from 0 to 500, with a mean score 245 (SD = ± 55). According to Kutner et al. (2003), the National Research Council categorizes individual HL scores on the NAAL scale into four groups: below basic (0-184); basic (185-225), intermediate (226-309), and proficient (310-500). Individuals who are able only to circle an appointment date on a slip are considered as having an HL level that is below basic. Individuals who can apply knowledge from given health information and provide two

reasons to test for a specific disease have a basic level of HL. An intermediate or a proficient level of HL refers to the ability to perform a moderate task (e.g., follow directions on prescribed drug label) or more complex and challenging tasks, including numeracy (Martin et al., 2009). The predictive models use the key sociodemographic factors of gender, age, ethnicity, highest educational attainment, SES, marital status, primary language, statistical area of residence, and length of time in the United States to compute the HL scores. Researchers can apply one of the predictive models to a nationally representative sample to estimate the HL mean and probability by using linear regression and logistic regression, respectively.

Although the validated predicted model is quite recent, Rasu et al. (2015) applied the models on MEPS data from 2005 to 2008 on a nationally representative sample to assess the impact of levels of HL on health care utilization and expenditure. A retrospective cohort study by Bailey et al. (2015) validated the Martin et al.'s (2009) proxy HL models against the three most commonly validated HL assessment instruments: TOFHLA, REALM, and NVS. The validation study found fair agreement between the derived HL and the direct measurements, thus providing further validity and precision to the predictive HL model.

The NHIS is a nationally representative survey and does not directly measure individual HL levels. However, the two validated predictive models can be applied to data from the multistage sampling design to estimate mean HL scores and the probability of individuals having adequate (i.e., intermediate or proficient) levels of HL.

Research Design

I designed the study to use quantitative secondary data to examine the relationship between the levels of HL and HPV vaccine uptake among racial minority young women (African Americans & Hispanic Americans) between the ages of 18 and 26 years who were living in the United States at the time of the study. I also explored the data to assess the association between ethnicity and HPV vaccine uptake while controlling for age and SES (income, education, and employment). The IVs of ethnicity and HL (based on sociodemographic characteristics) were evaluated against the DV of HPV vaccine uptake ($\geq$ 1 dose). The covariates of age, income, and education were measured on a continuous dependent-response Likert-type scale (Russell & Bobko, 1992). Using SPSS, I recoded some of the continuous variables such as HL level as categorical variables, for analytic purposes. Responses to the vaccine uptake were dichotomized: Responses representing vaccine uptake were code "1-Yes," and categorical responses indicating lack of vaccine uptake were coded "2-No." All other responses (i.e., "3-Doctor refused when asked," "7-Refused," "8-Not ascertained," and "9-Don't know" were excluded from the analysis).

The publicly available secondary data from NHIS facilitated this investigation into the relationships between the variables and answer the RQs. The use of secondary data also will help to advance scientific knowledge in areas where the use of primary data is difficult because of the high cost involved in data collection and the long follow-up time of the participants (Smith et al., 2011). The use of these data will make a unique contribution to the knowledge of science.

Population

In 2009, composition of the female population in the United States was as follows: 65.2% non-Hispanic European American, 15.0% Hispanic American, and 12.5% African American. By 2050, the composition is expected to be 46.1%, 29.9%, and 13.0% non-Hispanic European American, Hispanic American, and African American, respectively (U.S. Department of Health and Human Services, Health Resources and Services Administration [HRSA], 2011). According to the U.S. Census (2010), an estimated 11.5% African American women and 9.3% of Hispanic American women live in rural areas of the United States, where residents are more likely to have inadequate levels of HL because of fewer years of education, inadequate numbers of physicians and health specialists, and limited access to health care (HRSA, 2011). The Census data indicated that 56.9% of the women between ages 18 and 24 years were living with relatives, and another 14.1% were living with nonrelatives. Failure to consider the geographical distribution of minority women would likely have led to selection bias that could have affected the generalization of the findings. The sampling design of the NHIS accounted for the population distribution, and the variables in this study, which focused on adolescent and young adult women ages 18 to 26 years, were available in the 2015 NHIS data set.

Sampling Design

The NHIS's (2015) cross-sectional study involved face-to-face household interviews of noninstitutionalized civilians in the United States. Excluded from the study were residents of long-term care facilities, active-duty military personnel, and people

living outside the United States (as cited in Center for Health Statistics - Division of Health Interview Statistics, 2015). The NHIS used a complex and stratified multistage probability design to partition the primary sampling units (PSUs) into several strata and clusters: county, a small group of contiguous counties, or a metropolitan statistical area. Certain primary sampling units such as New York City, which have large populations, were labeled self-representing areas because they could be sampled adequately with certainty. Conversely, PSUs with smaller populations (non-self-representing units) were stratified based on geographical location. The design involved automatic selection of all self-representing PSUs, and a minimum of two non-self-representing from noncertainty areas also were selected without replacement, based on population size of the geographical region, as reported in the U.S. Census from 2000. Thus, every state had at least 2 PSUs included in the final selection, and states with more certainty areas had substantially more (NHIS, as cited in Center for Health Statistics, 2015). Each selected PSU was further subdivided into two nonoverlapping segments based on permit and area by using the number of building permits issued post the U.S. Census in 2000 and geographic location, respectively. The permit frame and area frame formed the NHIS sampling frame.

Besides the advantages offered by the complex stratified multistage probability design, the NHIS (2015) design purposefully oversampled African Americans, Hispanic Americans, and Asian Americans; in some area segments, the interviewers screened the household rosters and continued the interviews only if at least one African American, one Hispanic American, or one Asian American was identified within a household. Areas

with a higher concentration of minority populations had a higher probability of selection (CDC, 2015). In certain area segments, the interviewers terminated the interviews when the rosters did not contain any racial minority (African American, Hispanic American, or Asian American) adults. The NHIS was conducted by the National Center for Health Statistics (NCHS), part of CDC, in conjunction with the U.S. Census Bureau.

The publicly available data from the NHIS (2015) were obtained from 41,493 households, representing a response rate of 70.1% from 42,288 families and 103,672 noninstitutionalized individuals. The interviewers were unable to contact 9.5% of the eligible respondents, and 20.4% of the targeted participants either refused to participate or provided unacceptable interviews (CDC, 2015). Participants in the NHIS interviews did not receive any incentives or compensation; however, from May through July, the investigators did experiment with some incentives in the New York, Philadelphia, and Denver Census areas. Except for New York, there was no significant increase of the incentives on the response rate (CDC, 2015).

Data Collection

I focused on survey items in the household, personal, cancer, and adult sample files to extract the target population's sociodemographic features, motivational variables, and HPV vaccine uptake. The sociodemographic characteristics included, but were not limited to, country of birth, age, educational attainment, marital status, and SES). To collect data, field representatives (FRs), who were trained and supervised by the U.S. Census Bureau's regional offices sent a letter in advance to each household address selected for participation that explained the purpose of the NHIS, the average required

commitment time, and the confidentiality of the responses. The letter also explained that participation was voluntary and that a specific law existed to ensure the safe handling of all collected data. The FRs received annual refresher training on basic interviewing procedures, and they periodically received direct supervision by U.S. Census Bureau supervisors. The activities of the FRs were monitored by the Census Bureau's PANDA (performance and data analysis) computer system. On the interview day, an FR would arrive at the selected address and present another copy of the advance letter to each respondent to obtain verbal consent to participate (Center for Health Statistics - Division of Health Interview Statistics, 2015).

Upon receipt of consent, the FRs conducted face-to-face interviews at the respondents' homes, but if follow-up interviews were needed, follow-up was conducted via the telephone, if preferred. Instead of face-to-face interviews, respondents could opt for telephone interviews, so individuals who were out of reach because of travel distance or road impassability were interviewed over the telephone. The interviews were conducted in multiple languages.

A knowledgeable adult 18 years of age or older or a proxy from each randomly selected household was interviewed to provide information on cancer prevention knowledge, insurance coverage, use of health care services, and HPV vaccine uptake, and sociodemographic factors. The U.S. Census Bureau FRs who conducted the survey using computer-assisted personal interviewing (CAPI) system, applied computer software guided by the CAPI Reference Questionnaire on a computer screen during the interviews. Each adult interviewee was asked, "Have you ever received an HPV shot or vaccine?"

The response options were “1-Yes,” “2-No,” “3-Doctor refused when asked,” “7-Refused,” and “8-Do not know.” Respondents who indicated vaccine receipt were asked a follow-up question about the number of vaccines received and the age of first vaccine. The respondents also were asked about their access to and use of health care, especially regarding health insurance and difficulty paying their medical costs or choosing their coverage plan, respectively. Although 36,672 adults provided complete responses to the variables of interest, only 2,095 individuals were between the ages of 18 and 26 years, so they constituted the analytic sample for this dissertation.

Variables

Level of HL refers to the ability to acquire, process, understand, and apply health and health care information to make the appropriate health-related decisions (Somers et al., 2010). The WHO (2017) posited that HL involves cognitive and social skills that can influence the motivation to access and use health information to promote health. The WHO definition effectively incorporates the social determinants of health, that is, the social, political, and environmental factors, that might render individuals or communities susceptible to negative health outcomes (Krieger, 2001). The HL mean scores for the participants in this study were derived by proxy, that is, by using predictive HL models. Ethnicity and all other variables used in this study had their direct measurements in the survey.

I applied the unstandardized regression coefficients of the predictive HL model to the NHIS data from 2015 to derive proxy HL scores, using known sociodemographic

variables from the NHIS data. The IVs of age, education, marital status, and SES in the NHIS data sets were categorized to comply with Martin et al.'s (2009) model.

Data Merge

The publicly available NHIS (2015) data existed in seven separate tables, but because the data were not primarily collected for the current study, I excluded the variables in the data that were not relevant to this study from the merged table. Upon receipt of approval from Walden University's Institutional Review Board (IRB approval No.11-09-17-0154427) to conduct the study, I examined each data set to remove the irrelevant ones. I also examined the missing data and extreme outliers. Extreme outliers and instrumental variables and cases with more than 30% missing data were excluded from the analysis. The appropriate tables were merged and manipulated before data analysis.

Descriptive Statistical Analysis

The descriptive statistics of this study included sample size, measure of dispersion, and central tendency measurement. The results of the descriptive statistics were presented in tables (Forthofer, Lee, & Hernandez, 2007; Marshall & Jonker, 2010; Spriestersbach, Röhrig, du Prel, Gerhold-Ay, & Blettner, 2009). The mean or median values, skewness, and kurtosis were reported on the continuous variables of age, income, and the highest level of educational attainment. For the categorical and nominal variables (HPV vaccine uptake, ethnicity, health insurance status, and health care use), the descriptive statistics were reported with total counts and their associated percentages (Forthofer et al., 2007). In addition to the counts for the categorical variables, cross-

tabulations that displayed missing values and their characteristics were presented to inform readers about the validity of the results, inferences, and generalizability (Kang, 2013). The age variable was recoded to two categories (18-26 years and 26+ years) to separate data from the population of interest from the rest of the data.

Inferential Statistics

The RQs and hypotheses were as follows:

1. Does HL level relate to the HPV vaccine uptake of marginalized adolescent and young adult women, ages 18 to 26 years, living in the United States, after controlling for the effects of income, educational level, and age?

H_{01}: There is no significant relationship between HL and HPV vaccine uptake among marginalized adolescent and young adult women, ages 18 to 26 years, women, ages 18 to 26 years, living in the United States, controlling for the effects of income, educational level, and age.

H_{a1}: There is a significant relationship between HL and HPV vaccine uptake among marginalized adolescent and young adult women, ages 18 to 26 years, women, ages 18 to 26 years, living in the United States, controlling for the effects of income, educational level, and age.

2. Does ethnic background relate to the HPV vaccine uptake of marginalized adolescents and young adult women, ages 18 to 26 years, women, ages 18 to 26 years, living in the United States, after controlling for the effects of income, educational level, and age?

H_{02}: There is no significant relationship between ethnic background and HPV vaccine uptake of marginalized adolescent and young adult women, ages 18 to 26 years, living in the United States, controlling for the effects of income, educational level, and age.

H_{a2}: There is a significant relationship between ethnic background and HPV vaccine uptake of marginalized adolescent and young adult women, ages 18 to 26 years, women, ages 18 to 26 years, living in the United States, controlling for the effects of income, educational level, and age.

Test of Assumptions

Before testing the hypotheses, I examined the data for normality by assessing the sampling distribution means and the relevant parameter estimates (Field, 2014). I applied statistical tests of normality to the data to test for the normality of distribution. I also conducted ANOVA to look for a nonsignificant *p* value for the Levene's test to test for any presence of homoscedasticity or homogeneity of variance. A *p* value of .05 or greater was considered not significant and led to rejection of the null hypothesis, which assumed equal variance among the different groups.

Continuous and Categorical Variables

I assessed all continuous variables (age, income, and highest educational attainment) by using *t* test to detect any significant differences between the vaccinated and the unvaccinated respondents. The categorical variables of health insurance coverage, flu shot uptake, and Pap smear status were evaluated with the chi-square test to assess the presence of significant differences between the vaccinated and unvaccinated groups.

Inferential Statistical Analysis

The IV of HL was dichotomized to below basic and above basic; the DV of HPV vaccine uptake was measured on nominal scales, so a chi-square test for the association was performed to assess whether there was a significant relationship between the variables of interest. The chi-square goodness-of-fit test was used to assess the normality of distribution by examining the sizes of the chi-square statistic and the *p* value. Besides the chi-square test, counts with associated percentages and 95% CIs for the vaccine uptake were estimated by sociodemographic characteristics and motivational variables.

I conducted bivariate logistic regression and chi-square tests for bivariate comparisons, and I used forced multivariate logistic regression analysis to examine the association between the variables of interest, namely, HL, ethnicity, and HPV vaccine uptake, among the sample. To assess the relationship between the derived HL and HPV vaccine uptake, I conducted a bivariate logistic regression to investigate whether there was an association between the two variables. A multivariable logistic regression was performed for odds ratios (ORs) of HPV vaccine uptake between respondents with adequate levels of HL and those with below-basic or basic levels of HL. The model was adjusted for the effects of the clustering design. All statistical analyses were conducted using SPSS v.21.

Summary

Data from the household, personal, cancer, and adult sample files of the 2015 NHIS were extracted and merged on the household number (HHX), and cleaned to remove cases with missing variables. All the variables in the study that is sociodemographic

characteristics needed to compute the HL levels, motivation variables, and the HPV vaccine uptake were contained in the existing data. Only the data on the noninstitutional young adult women ages 18 to 26 years at the time of the survey and living in the United States were extracted to provide the descriptive statistics. The inferential statistics such as the multivariable logistical regression, chi-square, and the *t* tests to answer the two RQs were all based on the data extracted from the existing 2015 NHIS data on the young adult women.

Preview of Chapter 4

In the data analysis section, I applied the validated model by Martin et al. (2009) to compute the HL levels of the participants and conducted a series of statistical analyses to examine associations between the variables. The two null hypotheses in this study and the underlying statistical assumptions of the logistical regression were tested as part of the statistical analysis. The result of the final multivariable logistical regression model as well as the ORs explaining the relationships between the variables in this study are presented in the following chapter.

Chapter 4: Results

I conducted this study to assess whether there was a relationship between HL levels and HPV vaccine uptake among noninstitutionalized racial minority African American and Hispanic American young women between the ages of 18 and 26 years who were living in the United States at the time of the study. Respondents' HL levels were derived from sociodemographic variables (i.e., gender, age, ethnicity, highest education level attainment, FPL, marital status, and English proficiency) using a validated model by Martin et al. (2009) based on the NAAL (2003). The second purpose of the study was to determine whether ethnicity was related to HPV vaccine uptake. HL level and ethnicity were the IVs, and HPV vaccine uptake of at least one dose was the DV. Age, income level (FPL), health insurance, HPV awareness, and highest educational attainment were treated as other explanatory variables.

I assessed the relationships between the IVs of HL and ethnicity and the DV of HPV vaccine uptake using secondary data from the NHIS (2015). The following files, namely sample adult, household, cancer, family, and personal files of the NHIS were merged, and analyzed to facilitate the examination of possible relationships. All statistical analyses on the data were performed using SPSS, v.21.

I performed a *t* test for continuous variables (age and income) and chi-square tests for the categorical variables to assess the presence of significant differences between the vaccinated and unvaccinated groups. I conducted simple binary logistic regression tests to assess the RQs and their hypotheses. I used a two-stage, predicted, residual inclusion technique, applying the instrumental variables and confounders to control endogeneity. I

then conducted a multivariate logistic regression test that included the residual variable as an additional regressor, all other factors of the IVs, and the covariates to identify IV variables that significantly predict the outcome variable of HPV vaccine uptake.

Research Questions and Hypotheses

The RQs and hypotheses were as follows:

3. Does HL level relate to the HPV vaccine uptake of marginalized adolescent and young adult women, ages 18 to 26 years living in the United States, after controlling for the effects of income, educational level, and age?

H_{01}: There is no significant relationship between HL and HPV vaccine uptake among marginalized adolescent and young adult women, ages 18 to 26 years living in the United States, controlling for the effects of income, educational level, and age.

H_{a1}: There is a significant relationship between HL and HPV vaccine uptake among marginalized adolescent and young adult women, ages 18 to 26 years living in the United States, controlling for the effects of income, educational level, and age.

4. Does ethnic background relate to the HPV vaccine uptake of marginalized adolescents and young adult women, ages 18 to 26 years living in the United States, after controlling for the effects of income, educational level, and age?

H_{02}: There is no significant relationship between ethnic background and HPV vaccine uptake of marginalized adolescent and young adult women, ages 18 to

26 years living in the United States, controlling for the effects of income, educational level, and age.

H_{a2}: There is a significant relationship between ethnic background and HPV vaccine uptake of marginalized adolescent and young adult women, ages 18 to 26 years living in the United States, controlling for the effects of income, educational level, and age.

Data Analysis

This section discusses the descriptive and inferential statistics. The predictor variables in the study were HL level and ethnicity; the outcome variable was HPV vaccine uptake. The descriptive statistics provided information on the sociodemographic variables that contributed to the computation of the HL scores and the other predictor variables.

Descriptive Statistics

Sociodemographic Factors

The descriptive statistics were focused on the sociodemographic factors of gender, age, marital status, highest level of educational attainment, FPL, and English proficiency that were applied to Martin et al.'s (2009) model to compute HL levels. Two of the participants failed to provide information on how well they spoke English. Besides the missing information on English fluency, all 2,095 respondents provided information on the rest of the sociodemographic variables (see Table 1).

Table 1

Sample Size per Instrumental Variables

		Ethnicity	Education category	How well English is spoken	Marital status	INCGRP5	FPL	Born in the U.S.
N	Valid	2,095	2,095	2,093	2,095	2,095	2,095	2,095
	Missing	0	0	2	0	0	0	0

Sex and age. There were a total of 2095 female participants between the ages of 18 and 26 years in this study (see Table 2). The ages ranged from 18 to 26 years, with a mean age 22.49 years and a standard deviation of 2.489 (see Table 3). The age distribution was approximately symmetric (skewness = -0.245) and platykurtic (kurtosis = -1.089).

Table 2

Sex

N	Valid	2095
	Missing	0

Table 3

Age

	N	Min	Max	*M*	*SD*
Age	2095	18	26	22.49	2.489
Valid *N* (listwise)	2095				

Table 4 is the frequency table providing information about the following sociodemographic factors.

Ethnicity. Of the 2,095 respondents, 1,096 (52.3%) self-identified as European Americans, 485 (23.2%) as Hispanic Americans, 349 (16.7%) as African Americans, 125 (6.0%) as Asian Americans, and 40 (1.9%) as Multiracial.

Marital status. Participants' marital status was categorized into three groups: never married; divorced, separated, widowed; and married. Of the 2.095 participants, 1,659 (79.0%) had never married; 389 (18.6%) were married; and 50 (2.4%) were divorced, separated, or widowed.

Educational level. Highest educational attainment was categorized into five groups: less than high school (HS); HS or its equivalency (GED); some college education; associate degree; and bachelor's or higher degree. Of the 2,095 participants, 739 (35.3%) reported up to HS or its equivalent as their highest educational attainment; 30% had some college education; 198 (9.5%) had an associate degree; and 532 (25.4%) had a bachelor's degree or higher.

Annual household income and FPLs. About 50% of the respondents reported a total annual household incomes below $35,000, 26.6% had annual incomes ranging from $35,000 to $74,999, and 9.3% reported annual household income of more than $100,000. Totals of 54% European American, 58% Hispanic American, and 68% African American participants reported annual household incomes of below $35,000. About a fourth of the young adult women's household incomes were below 100% FPL, and 19.2%, 16.4%, and 23.4% had 100% to 200% FPL, 200% to 300% FPL, and over 300% FPL. Totals of 22.7% of the European American, 34% of the Hispanic American, and 47% of the African American participants were below 100% FPL, respectively.

English proficiency. The respondents' English proficiency ranged from "very well proficiency" to "not at all." A total of 1,966 (93.9%) of the respondents self-reported good English fluency, and 127 (6.1%) reported poor English fluency.

Place of birth. A total of 1,668 (79.6%) of the respondents were born in the United States, and 426 (20.3%) were born outside the United States.

Table 4

Frequency Table for Ethnicity, Marital Status, Education, Income, English Proficiency, and Place of Birth

		Frequency	%	Valid %	Cumulative %
Ethnicity					
Valid	European American	1096	52.3	52.3	52.3
	Hispanic American	485	23.2	23.2	75.5
	African American	349	16.7	16.7	92.1
	Asian American	125	6.0	6.0	98.1
	Other races	40	1.9	1.9	100.0
	Total	2095	100.0	100.0	
Marital status					
	Never married	1656	79.0	79.0	79.0
	Divorced, separated, widowed	50	2.4	2.4	81.4
	Married	389	18.6	18.6	100.0
	Total	2095	100.0	100.0	
Education					
	< HS	254	12.1	12.1	12.1
	HS/GED	485	23.2	23.2	35.3
	Some college, no degree	626	29.9	29.9	65.2
	Associate	198	9.5	9.5	74.6
	≥ Bachelors	532	25.4	25.4	100.0
	Total	2095	100.0	100.0	
Annual income					
	$0 -$34,999	1052	50.2	50.2	50.2
	$35,000 -$74,999	558	26.6	26.6	76.8
	$75,000 -$99,999	143	6.8	6.8	83.7
	$100,000 and over	195	9.3	9.3	93.0
	Undefined	88	4.2	4.2	97.2
	Unknown	59	2.8	2.8	100.0
	Total	2095	100.0	100.0	
FPL					
	< 100% FPL	531	25.3	25.3	25.3
	100-200% FPL	402	19.2	19.2	44.5
	200-300% FPL	343	16.4	16.4	60.9
	Other	328	15.7	15.7	76.6
	≥ 300% FPL	491	23.4	23.4	100.0
	Total	2095	100.0	100.0	
English proficiency					
	Very well	1841	87.9	88.0	88.0
	Well	125	6.0	6.0	93.9
	Not well	87	4.2	4.2	98.1

		Frequency	%	Valid %	Cumulative %
	Not at all	40	1.9	1.9	100.0
	Total	2093	99.9	100.0	
Missing	System	2	.1		
Total	2095	100.0			
Place of birth					
	Born in the US	1668	79.6	79.7	79.7
	Born outside the US	426	20.3	20.3	100.0
	Total	2094	100.0	100.0	
Missing	System	1	.0		
Total	2095	100.0			

Health Literacy

Based on the NAAL scale, which ranges from zero to 500, with an average score of 252, the minimum and maximum HL scores for the participants were 212 and 298 (see Table 5). One hundred and ninety (9.1%) participants had HL levels that were below basic, 1,891 (90.9%) had HL levels above basic, and 14 (0.7%) were missing data for at least one of the sociodemographic variables used to compute HL scores.

The derived HL level scores ranged from 212 to 298 (M = 256.18, SD = ± 22.10). None of the participants had below-basic (0-180) or proficient (310-500) HL scores. HL level showed a skewness and kurtosis of -0.146 and -1.080, respectively. Table 6 shows two missing data, so further statistical analyses were based on 2,093 respondents. Table 7 presents the HL adequacy (“above basic” and “below basic”) on the participants.

Table 5

Descriptive Derived HL Scores

	N	Min	Max	*M*	*SD*
Derived HL level	2093	212	298	256.07	22.098
Valid *N* (listwise)	2093				

Table 6

HL Adequacy

		Frequency	%	Valid %	Cumulative %
	Below basic	190	9.1	9.1	9.1
Valid	Above basic	1891	90.3	90.9	100.0
	Total	2081	99.3	100.0	
Missing	System	14	.7		
Total		2095	100.0		

The mean HL scores of female European American, African American, and Hispanic American respondents were 273.42 (*SD* = ± 11.20), 234.19 (*SD* = ± 11.27), and 232.55 (*SD* = ±11.38), respectively. All of the European American female respondents demonstrated HL levels that were above basic, whereas 131 (28%) of the Hispanic American and 58 (16%) of the African American women had HL levels below basic (see Table 7).

Table 7

Cross-Tabulation: HL Adequacy and Ethnicity

		Ethnicity					Total
		European American	Hispanic American	African American	Asian American	Other	
Health literacy adequacy	Below basic	0	131	58	0	1	190
	Above basic	1,096	344	287	125	39	1,891
Total		1,096	475	345	125	40	2,081

Motivating Variables

Health Insurance

Health insurance status can influence access to the health care system. Table 8 shows that 286 (13.7%) of the respondents had no health insurance coverage and 1,796 (86.3%) did have health insurance coverage. Most of the respondents with health insurance coverage (*n* =1,263, 60.3%), reported that it was private health insurance; 387 (18.5%) of those with health insurance coverage reported Medicaid or other public assistance as their health insurance coverage.

Table 8

Health Insurance Status

		Frequency	%	Valid %	Cumulative %
Valid	No health insurance coverage	286	13.7	13.7	13.7
	Health insurance coverage	1,796	85.7	86.3	100.0
	Total	2,082	99.4	100.0	
Missing	System	13	.6		
Total		2,095	100.0		

HPV Awareness

Knowing about HPV might affect the capacity of individuals to access and acquire the vaccine. Of the 1,964 participants who gave definitive responses to the survey question, "Have you ever heard of HPV?", 429 (20.5%) reported that they had never heard of HPV, and 1,535 (73.3%) reported that they did have some awareness of the virus (see Table 9). No HPV awareness information was obtained from 119 (5.7%) participants. HPV awareness percentages were 85.1% for the European American, 78.5% for the African American, and 66.0% for the Hispanic American participants.

Table 9

Frequency Table Showing Awareness of HPV

Had heard of HPV		Frequency	%	Valid %	Cumulative %
Valid	Yes	1,535	73.3	73.3	73.3
	No	429	20.5	20.5	93.7
	Refused	8	.4	.4	94.1
	Not ascertained	119	5.7	5.7	99.8
	Do not know	4	.2	.2	100.0
	Total	2,095	100.0	100.0	

Pap Smear

A Pap smear is a routine cervical examination by a qualified health care provider in which a cell sample from the cervix is sent to a laboratory for analysis of abnormalities. Women with a Pap smear history might use the same skill set to uptake the HPV vaccine. As seen in Table 10, 614 (29.3%) participants had never had a Pap smear, 1,134 (54.1%) had not used OB/GYN services in the past year, and 628 (30%) had not had an HPV test with Pap smear, 804 (38.4%) had acted upon a doctor's recommendation to have the most recent Pap smear or HPV test, and 968 (46.2%) indicated that they had not had any recommendations from their health care providers. The Pap smear percentages by group were 72.3% European American, 76.2% African American, and 63.4% Hispanic American participants.

Table 5

Frequency Table Regarding Pap Smear

		Frequency	%	Valid %	Cumulative %
Had a Pap smear					
Valid	Yes	1357	64.8	64.8	64.8
	No	614	29.3	29.3	94.1
	Refused	6	.3	.3	94.4
	Not ascertained	116	5.5	5.5	99.9
	Do not know	2	.1	.1	100.0
	Total	2095	100.0	100.0	
Seen/talked to OB/GYN					
Valid	Yes	935	44.6	44.6	
	No	1134	54.1	54.1	
	Not ascertained	26	1.2	1.2	
	Total	2095	100.0	100.0	
Had HPV test With Pap smear					
Valid	Yes	547	26.1	40.3	40.3
	No	628	30.0	46.3	86.6
	Refused	2	.1	.1	86.7
	Not ascertained	3	.1	.2	87.0
	Do not know	177	8.4	13.0	100.0
	Total	1357	64.8	100.0	
Missing	System	738	35.2		
Total		2095	100.0		
Doctor recommended Pap or HPV test					
Valid	Yes	804	38.4	40.4	40.4
	No	968	46.2	48.6	89.0
	Did not see a doctor in past 12 months	93	4.4	4.7	93.7
	Refused	3	.1	.2	93.9
	Not ascertained	121	5.8	6.1	99.9
	Do not know	1	.0	.1	100.0
	Total	1990	95.0	100.0	
Missing	System	105	5.0		
Total		2095	100.0		

Flu Vaccine Uptake

The National Advisory Committee on Immunization (2015) recommends annual flu vaccine for individuals who are 6 months of age or older. The habit of receiving flu

vaccine by healthy individuals might influence their HPV vaccine uptake. Table 11 presents the frequency results of participants who had received the flu vaccine within the past 12 months. Information on 35 (1.7%) individuals was missing from the primary data, 1,419 (67.7%) did not receive the flu vaccine during the past 12 months, and 641 (30.6%) reported receiving the vaccine.

Table 11

Flu Vaccine Uptake

		Frequency	%	Valid %	Cumulative %
	Yes	641	30.6	31.1	31.1
Valid	No	1,419	67.7	68.9	100.0
	Total	2,060	98.3	100.0	
Missing	System	35	1.7		
Total		2,095	100.0		

General Health Status

General health status might impact attitudes or health behavior decisions. Attitudinal and normative beliefs are salient in distal behaviors such as vaccinations that can prevent cancer in the future. Healthy individuals concerned about vaccine safety or efficacy might process health information differently from people in poor health. In response to the survey question "Would you say your health, in general, is excellent, very good, good, fair, or poor?" 1,909 (91.1%) participants reported health status being good or better, 160 (7.6%) reported fair health, and 26 (1.2%) reported poor health (see Table 12).

Table 12

Perceived Health Status

		Frequency	%	Valid %	Cumulative %
Valid	Excellent	694	33.1	33.1	33.1
	Very good	727	34.7	34.7	67.8
	Good	488	23.3	23.3	91.1
	Fair	160	7.6	7.6	98.8
	Poor	26	1.2	1.2	100.0
	Total	2,095	100.0	100.0	

Geographic Region

Geographic variation in HPV vaccine uptake has been reported in the literature (Rahman et al., 2014). Table 13 shows the frequency regarding the geographical region. The composition of the young adult female respondents was 292 (13.9%) Northeast, 432 (20.9%) Midwest, 778 (37.1%) South, and 587 (28.0%) West.

Table 13

Region

		Frequency	%	Valid %	Cumulative %
Valid	Northeast	292	13.9	13.9	13.9
	Midwest	438	20.9	20.9	34.8
	South	778	37.1	37.1	72.0
	West	587	28.0	28.0	100.0
	Total	2095	100.0	100.0	

HPV Vaccine Status

Table 14 shows the HPV vaccine uptake status. Of the 1,952 participants who provided definitive answers to the survey question, “Have you ever received an HPV shot or vaccine?” 1,115 (53.2%) of the female respondents indicated no receipt of the vaccine, 837 (40.0%) reported vaccine receipt, and data for 143 (6.8%) were missing.

Table 14

HPV Vaccine Status

		Frequency	%	Valid %	Cumulative %
	No	1115	53.2	57.1	57.1
Valid	Yes	837	40.0	42.9	100.0
	Total	1952	93.2	100.0	
Missing	System	143	6.8		
Total		2095	100.0		

One-Sample *t* Test

I performed a one-sample *t* test to assess whether there was a significant difference in the mean ages of vaccinated and unvaccinated participants. Table 15 shows the result of the *t* test. The sample mean age of 22.24 (*SD* = ± 2.44) for the vaccinated group was significantly different from the sample mean age of 22.70 (*SD* = ± 2.49) for the unvaccinated group, $t(1950) = -4.1$, $p < .001$ (two-tailed); 95% CI (-0.68, -0.24). The result in Table 15 indicates that women who reported of receiving the HPV vaccine were significantly younger than the women who did not receive the vaccine.

Table 15

Group Statistics for Ever Having Received HPV Vaccine by Age

Ever received HPV vaccine		*N*	*M*	*SD*	*SEM*
Age	Yes	837	22.24	2.440	.084
	No	1115	22.70	2.494	.075

Health Literacy and HPV Vaccine Uptake

I performed a *t* test to determine if there is a significant mean difference in HL scores between the vaccinated and unvaccinated groups. Table 16 presents the group statistics of the results. The sample HL mean score of 259.12 (*SD* = ± 21.86) for the

vaccinated group was significantly different from a mean score of 254.20 (*SD* = ± 22.12) for the unvaccinated group, $t(1948) = 4.88$, $p < .001$ (two-tailed), 95% CI (2.94, 6.90).

Table 16

Group Statistics for Ever Having Received HPV Vaccine by Derived HL

Ever received HPV vaccine		*N*	*M*	*SD*	*SEM*
Derived health literacy level	Yes	835	259.12	21.863	.757
	No	1115	254.20	22.122	.663

Hypothesis Testing

H_{01}: There is no significant relationship between HL and HPV vaccine uptake among marginalized adolescent and young adult women, ages 18 to 26 years, living in the United States, controlling for the effects of income, educational level, and age.

H_{a1}: There is a significant relationship between HL and HPV vaccine uptake among marginalized adolescent and young adult women, ages 18 to 26 years, living in the United States, controlling for the effects of income, educational level, and age.

To test Hypothesis 1, I performed a cross-tabulation analysis. Tables 17 and 18 show the results of the cross-tabulation. Table 17 shows that this hypothesis testing was based on a total,1940 (92.6%) participants, with 155 (7.4%) being excluded from the testing because the HPV vaccine uptake was not ascertained or the respondents did not know their vaccine uptake status.

Table 17

HL Levels and Responses on HPV Vaccine Status

	Cases					
	Valid		Missing		Total	
	N	%	*N*	%	*N*	%
HPV vaccine status by HL adequacy	1,940	92.6%	155	7.4%	2095	100.0%

A two-way contingency table analysis was conducted to evaluate whether HL levels were related to young adult females' HPV vaccine uptake. HPV vaccine uptake and HL level were found to be significantly related, Pearson chi-square statistic, $\chi^2(1, 1940) = 14.51$, $p < .001$ (two-sided); continuity correction $(1, 1940) = 13.915$, $p < .001$ (two-sided); Cramer's V = 0.086 (see Table 18). Because there was no significant association between HL and HPV vaccine uptake, Null Hypothesis 1 is rejected.

Table 18

Contingency Table: HPV Vaccine Uptake and HL Adequacy

			HL adequacy		Total
			Below basic	Above basic	
HPV vaccine uptake	Yes	Count	53	782	835
		Expected count	77.0	758.0	835.0
		% within HPV vaccine data	6.3%	93.7%	100.0%
		% within HL adequacy	29.6%	44.4%	43.0%
		Adjusted residual	-3.8	3.8	
	No	Count	126	979	1105
		Expected count	102.0	1003.0	1105.0
		% within HPV vaccine data	11.4%	88.6%	100.0%
		% within HL adequacy	70.4%	55.6%	57.0%
		Adjusted residual	3.8	-3.8	
Total		Count	179	1761	1940
		Expected count	179.0	1761.0	1940.0
		% within HPV vaccine data	9.2%	90.8%	100.0%
		% within Health literacy adequacy	100.0%	100.0%	100.0%

Note. Pearson $\chi^2 = 14.513$, $p < .001$

I conducted a pairwise follow-up comparison to evaluate the significant difference between the proportions by calculating the adjusted standardized residual *z* scores to control for Type I error at the .05 level across the groups. The adjusted residual values were used to compute the chi-square statistic and the *p* value. The calculated *p* values were compared to the adjusted Bonferroni corrected *p* value of .0125 (0.05 / 4 analyses). The calculated *p* value of the adjusted residual values was 0.000145, less than the adjusted Bonferroni corrected *p* value. Null Hypothesis 1 was rejected.

H_{02}: There is no significant relationship between ethnic background and HPV vaccine uptake of marginalized adolescent and young adult women, ages 18 to

26 years, living in the United States, controlling for the effects of income, educational level, and age.

H_{a2}: There is a significant relationship between ethnic background and HPV vaccine uptake of marginalized adolescent and young adult women, ages 18 to 26 years, living in the United States, controlling for the effects of income, educational level, and age.

Testing of this hypothesis involved 1,940 (93.2%) of the participants with 141 (6.8%) participants being excluded because inadequate information was ascertained or provided (see Table 19).

Table 19

Case Summary

	Cases					
	Valid		Missing		Total	
	N	%	*N*	%	*N*	%
HPV vaccine status by ethnicity	1940	93.2%	141	6.8%	2081	100.0%

A contingency table analysis was conducted to determine whether ethnic background was related to young adult females' HPV vaccine uptake. HPV vaccine uptake and ethnic background were found to be significantly related, Pearson chi-square statistic, $\chi^2(4, 1940) = 20.49$, $p < .001$ (two-sided; see Table 20).

Table 6

HPV Vaccine Data by Ethnicity: Cross-Tabulation

			Ethnicity					Total
			European American	Hispanic American	African American	Asian American	Other	
HPV vaccine uptake	Yes	Count	484	153	133	44	21	835
		Expected count	442.5	186.4	139.0	49.9	17.2	835.0
		% within HPV vaccine data	58.0%	18.3%	15.9%	5.3%	2.5%	100.0%
		Adjusted residual	3.8	-3.7	-.7	-1.1	1.2	
	No	Count	544	280	190	72	19	1105
		Expected count	585.5	246.6	184.0	66.1	22.8	1105.0
		% within HPV vaccine data	49.2%	25.3%	17.2%	6.5%	1.7%	100.0%
		Adjusted residual	-3.8	3.7	.7	1.1	-1.2	
Total		Count	1028	433	323	116	40	1940
		Expected count	1028.0	433.0	323.0	116.0	40.0	1940.0
		% within HPV vaccine data	53.0%	22.3%	16.6%	6.0%	2.1%	100.0%

Note. Pearson $\chi^2 = 20.49$, $p < .001$

I conducted follow-up pairwise comparisons to evaluate the difference among the ethnic groups, using Bonferroni method to control Type I error at the .05 level across all comparisons. The only significant pairwise comparison difference was between the European American and Hispanic American participants, Pearson chi-square, χ^2 (1, 1470) = 18.85, $p < .001$ (see Table 21). The alpha values of the Pearson chi-square for the other pairwise comparisons between European American and African American ($p = .059$); European American and Asian American ($p = .061$); European American and Other ($p = .501$); and African American and Hispanic American ($p = .076$) participants were not significant.

Table 21

HPV Vaccine Uptake and Ethnicity Contingency Table

			Ethnicity		Total
			European American	Hispanic American	
HPV vaccine data	Yes	Count	484	154	638
		Expected count	446.2	191.8	638.0
		% within HPV vaccine data	75.9%	24.1%	100.0%
	No	Count	544	288	832
		Expected count	581.8	250.2	832.0
		% within HPV vaccine data	65.4%	34.6%	100.0%
Total		Count	1028	442	1470
		Expected count	1,028.0	442.0	1470.0
		% within HPV vaccine data	69.9%	30.1%	100.0%

Note. Pearson $\chi^2 = 18.85$, $p < .001$

Test of Assumptions

Testing for Linearity of the Logit

I conducted the test for linearity to check whether each of the continuous variables of Age [Age_P] and HL Levels [HLL] was linearly related to the log of the outcome variable (HPV vaccine uptake). I computed the natural log of each of the two variables and performed a binary logistic regression to include the interaction terms of each predictor variable and its log as covariates. Thus, in addition to entering each continuous predictor variable for main effect, I added the interactions (Age_P x Ln(Age_P) and HLL x Ln(HLL) to test for linearity. Table 22 shows the output that tests the assumption of linearity.

From Table 22, the interaction of Age_P x Ln(Age_P) was significant ($p = .010$), indicating that the main effect of Age_P violated the assumption of linearity of the logit.

The interaction of HLL x Ln(HLL) had a significance value greater than .05 (p = .183), indicating that the assumption of linearity of the logit had been met for HLL.

Table 22

Variables in the Equation

		B	*SE*	Wald	*df*	Sig.	Exp(B)
Step 1[a]	Age	-3.742	1.489	6.319	1	.012	.024
	HLL	.437	.338	1.665	1	.197	1.548
	HLL by LnHLL	-.069	.052	1.772	1	.183	.933
	AGE_P by LnAGE_P	.941	.364	6.693	1	.010	2.563
	Constant	4.573	14.380	.101	1	.750	96.853

Note. [a]Variable(s) entered on step 1: AGE_P, HLL, HLL * LnHLL , AGE_P * LnAGE_P .

Test for Multicollinearity

I conducted a logic regression analysis using HLL and age as the predictor variables and HPV vaccine uptake as the outcome variable to test for multicollinearity. The Coefficient data in Table 23 show that the tolerance statistic for the two predictor variables was 0.935, well above 0.2 and signaling the lack of collinearity in the data. Similarly, the average variance inflation factor (VIF) for each predictor variable was 1.070. The VIF was well below 10, so the regression might not have been biased. The multicollinearity assumption was met.

Table 23

Coefficients, Multicollinearity

Model		Collinearity statistics	
		Tolerance	VIF
1	Derived HL level	.935	1.070
	Age	.935	1.070

Note. a. DV: HPV vaccine uptake

Inferential Analysis

I conducted statistical analyses to compare the sociodemographic variables and the motivational variables of HPV knowledge, environmental factors, and habitual and salient behaviors by HL levels by using chi-square tests for all categorical variables. Table 24 shows that all the Pearson's chi-square statistics for the dichotomized HL scores and the sociodemographic variables were significant ($p < .05$).

Table 24

Contingency Table: Sociodemographic and HL Level

	Cases				
	Valid		Pearson's		*p* value
	n	%	χ^2	*df*	(two-sided)
Marital status group by health literacy adequacy	2,081	99.3%	11.38	2	.003
Age group category by health literacy adequacy	2,081	99.3%	28.69	1	< .001
FPL by health literacy adequacy	2,081	99.3%	163.90	4	< .001
Ethnicity by health literacy adequacy	2,081	99.3%	344.20	4	< .001
Education 1 category by health literacy adequacy	2,081	99.3%	860.22	4	< .001
English language by health literacy adequacy	2,081	99.3%	179.56	1	< .001
Place of birth by health literacy adequacy	2,080	99.3%	134.06	1	< .001

Note. N = 2,095

From Table 25, the relationships between respondents' HL levels and their perceived general health status, health insurance coverage, and HPV awareness were highly significant ($p < .001$). The relationships between HL levels and respondents'

experience with the flu vaccine, usual places of receiving health care, Pap smear experience, and geographical region were not significant.

Table 25

Contingency Table: Motivating Variables and HL Levels

	Cases				
	Valid				
	n	%	Pearson χ^2	*df*	*p* value (2-sided)
Flu vaccine uptake * HL adequacy	2048	97.8%	3.05	1	0.081
Perceived health status * HL adequacy	2081	99.3%	33.76	4	<0.001
Healthcare place * HL adequacy	571	27.3%	2.18	1	0.140
Health insurance coverage * HL adequacy	2068	98.7%	52.04	1	<0.001
Region * HL adequacy	2081	99.3%	4.048	3	0.214
HPV Awareness * HL adequacy	1953	93.2%	51.79	1	<0.001
Pap test * HL adequacy	1960	93.6%	2.25	1	0.133

I conducted series of bivariate analyses to determine whether there was significant association between the DV and the motivating variables of HPV awareness, Pap smear history, acceptance of flu vaccine, highest education attainment, FPL, perception of general health, and region of residence. Table 26 presents the unadjusted bivariate OR for HL. Individuals with HL scores below basic were 50.4% less likely to have been vaccinated with the HPV vaccine (unadjusted OR 0.496; 95% CI 0.35, 0.70; $p < .001$).

Table 26

Unadjusted OR, Health Literacy

		B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B)	
								Lower	Upper
Step 1[a]	HLL below basic	-.701	.176	15.844	1	< .001	0.496	0.351	0.701
	RES_1	-.006	.004	1.814	1	.178	0.994	0.986	1.003
	Constant	-.218	.048	20.404	1	< .001	0.804		

Note. [a.] Variable(s) entered on step 1: HLL_BINARY, RES_1.

Table 27 shows the bivariate analyses and associated unadjusted ORs for the sociodemographic variables. Compared to the European American women ethnicity was a significant predictor of the vaccine uptake for the Hispanic American participants (unadjusted OR = 0.60; 95% CI 0.477, 0.757, $p < .001$). However, ethnicity was not a significant predictor for the African American participants (unadjusted OR = 0.78; 95% CI 0.61, 1.01, $p = .059$). Highest educational attainment up to some college education (no degree) and bachelor's or higher degrees were significant predictors ($p < .035$) for vaccine initiation. Associate degree did not significantly predict vaccine uptake. Marital status and SES (FPL) only significantly predicted the outcome variable for married ($p < .001$) individuals and those earning above 300% of the FPL ($p < .001$). Being proficient in English and being born in the United States were significant in predicting vaccine uptake.

Table 27

Unadjusted OR of HPV Vaccine Uptake for Instrumental Variables

	N = 2095					95% CI for Exp(B)		
Variables	B	*SE*	Wald	*df*	Exp(B)	Lower	Upper	*p* value
Age (Years)								
18-22					Reference			
23-26	.267	.092	8.463	1	1.306	1.091	1.563	.004
Ethnicity								
European American			22.001	4	Reference			< .001
Hispanic	-.509	.118	18.690	1	0.601	0.477	0.757	< .001
African American	-.243	.129	3.556	1	0.784	0.609	1.010	.059
Asian American	-.376	.201	3.482	1	0.687	0.463	1.019	.062
Other	.217	.323	.452	1	1.242	0.660	2.338	.501
Education level								
<HS	-.933	.169	30.529	1	0.393	0.282	0.548	< .001
HS / GED	-.631	.133	22.556	1	0.532	0.410	0.690	< .001
Some college	-.257	.122	4.433	1	0.774	0.609	0.982	.035
Associate	-.315	.172	3.338	1	0.730	0.521	1.023	.068
>=Bachelor's			41.396	4	Reference			< .001

		N = 2095				95% CI for Exp(B)		
Variables	B	*SE*	Wald	*df*	Exp(B)	Lower	Upper	*p* value
FPL								
<100% FPL	-.339	.129	6.881	1	.712	.553	.918	.009
100-199% FPL	-.588	.141	17.274	1	0.556	0.421	0.733	< .001
200-299% FPL	-.416	.146	8.058	1	0.660	0.495	0.879	.005
Other	-.403	.152	7.006	1	0.668	0.496	0.901	.008
>= 300% FPL			19.444	4	Reference			.001
Marital status								
Never married	.458	.122	14.086	1	1.581	1.245	2.008	< .001
Divorced, separated, widowed	-.210	.338	.386	1	0.811	0.418	1.572	.535
Married			17.407	2	Reference			< .001
English fluency								
Fluent					Reference			< .001
Not fluent	-1.11	.234	22.567	1	0.329	0.208	0.521	< .001
Place of birth								
Born in US					Reference			
Not born in US	-.717	.122	34.437	1	0.488	0.384	0.620	< .001

Table 28 shows the bivariate results of motivating that could influence the ability to carry out recommended behaviors. Participants without any knowledge of HPV were 92.8% less likely to have been vaccinated against HPV, with unadjusted OR = 0.072 (95% CI 0.05, 0.11, $p < .001$). Individuals without health insurance coverage were 36.3% less likely to have been vaccinated against HPV, unadjusted OR = 0.64 (95% CI 0.48, 0.84; $p = .001$). Participants who reported no flu vaccine uptake in the past 12 months were 35% less likely to report HPV vaccine uptake, unadjusted OR = 0.65 (95% CI 0.54, 0.79; $p < .001$). Individuals who had never had a Pap smear were 32.3% less likely to have been vaccinated, unadjusted OR = 0.68 (95% CI 0.55, 0.83; $p < .001$). Participants who were somewhat worried about paying for the medical cost (if they got sick) were 24.3% less likely to have been vaccinated against the HPV, unadjusted OR = 0.76 (95% CI 0.61, 0.94, $p = .011$). Respondents who reported having usual places for health care

services and transportation problems regarding health care services were not significant in predicting their HPV vaccine uptake status.

Table 28

Unadjusted OR of HPV Vaccine Uptake

N = 2095						95% CI for Exp(B)		
Variables	B	*SE*	Wald	*df*	Exp(B)	Lower	Upper	*p* value
HPV awareness								
Yes					Reference			
No	-2.631	.197	178.626	1	0.072	0.049	0.106	< .001
Health insurance coverage								
Yes					Reference			
No	.451	.140	10.411	1	0.637	0.484	.838	.001
Perceived health status								
Excellent			12.113	4	Reference			.017
Very good	-.653	.436	2.249	1	0.520	0.222	1.222	.134
Good	-.288	.435	.439	1	0.750	0.320	1.758	.507
Fair	-.490	.439	1.245	1	0.613	0.259	1.448	.264
Poor	-.517	.459	1.267	1	0.597	0.243	1.466	.260
Usual place for health services								
Yes					Reference			
No	.090	.184	.238	1	1.094	0.763	1.569	.625
Region								
Northeast			18.384	3	Reference			
Midwest	-.303	.158	3.712	1	.738	0.542	1.005	.054
South	-.588	.144	16.637	1	.556	0.419	0.737	< .001
West	-.475	.150	10.062	1	.622	0.464	0.834	.002
Flu vaccine uptake								
Yes					Reference			
No	-.429	.099	18.885	1	.651	0.536	0.790	< .001
Pap smear experience								
Yes					Reference			
No	-.390	.103	14.381	1	.677	0.554	0.828	< .001
Health care delay, transportation								
Yes	.438	.267	2.687	1	1.550	0.918	2.617	.101
No					Reference			
Medical cost								
Worried	-.278	.110	6.460	1	.757	0.611	0.938	.011
Not worried					Reference			

Interaction of the Independent Variables

I conducted logistic regressions to assess the interaction effect of the variables. I found an interaction effect between age and the following IVs: HL level, education, and SES (FPL). There also were interaction effects between FPL and education as well as FPL and marital status.

Adjusted ORs. I conducted a forced multivariate logistical regression to determine the adjusted ORs (AORs) for the variables at 95% CI. Results are presented in Tables 29 and 30.

From Table 29, the AORs of HPV vaccine uptake for the sociodemographic variables showed that neither participants' ethnicity, English proficiency, nor HL in the model significantly predicted the outcome variable of HPV vaccine uptake. However, highest education attainment significantly predicted the outcome variable. The marital status of participants who had never married and those who were married significantly predicted the probability of HPV vaccine uptake. Marital status of "divorced, separated, or widowed" did not significantly predict the outcome variable (AOR = 0.92; 95% CI 0.46, 1.18; p = .801). Similarly, individuals in the FPL status of 100% to 200% FPL and 200% to 300% FPL were 32.2% (AOR = 0.68; 95% CI 0.51, 0.91; p = .009) and 27.7% (AOR = 0.72; 95% CI 0.54, 0.97; p = .033), respectively, less likely to report vaccine receipt. Participants between the ages of 23 and 26 years were 28.6% less likely to have received the vaccine when compared to participants between the ages of 18 and 22 years (AOR = 0.71, 95% CI 0.58, 0.87; p = .001). Individuals who were born outside the United States were 40% less likely to receive the HPV vaccine (AOR = 0.60, 95% CI

0.44, 0.82, $p = .002$).

Table 29

AORs of HPV Vaccine Uptake, Sociodemographic Variables

		B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B)	
								Lower	Upper
Step 1[a]	Ethnicity								
	European American			3.176	4	.529			
	Hispanic American	-.010	.145	.005	1	.943	.990	.745	1.314
	African American	-.157	.139	1.278	1	.258	.855	.651	1.122
	Asian American	-.177	.230	.593	1	.441	.838	.534	1.314
	Multicultural	.340	.332	1.052	1	.305	1.405	.733	2.693
	Education level								
	≥ Bachelor's			22.088	4	.000			
	< HS	-.540	.228	5.583	1	.018	.583	.373	.912
	HS/GED	-.679	.146	21.723	1	.000	.507	.381	.675
	Some associates	-.351	.134	6.803	1	.009	.704	.541	.917
	Associate	-.356	.179	3.972	1	.046	.701	.494	.994
	English, less proficient	-.408	.275	2.202	1	.138	.665	.388	1.140
	Married			9.186	2	.010			
	Never married	.369	.131	7.923	1	.005	1.446	1.119	1.870
	Divorced, separated, widowed	-.088	.350	.064	1	.801	.915	.461	1.818
	≥ 300% FPL			8.297	4	.081			
	< 100% FPL	-.179	.144	1.532	1	.216	.836	.630	1.110
	100%-200% FPL	-.388	.150	6.734	1	.009	.678	.506	.909
	200%-300% FPL	-.324	.152	4.572	1	.033	.723	.537	.973
	Other	-.162	.164	.971	1	.324	.851	.617	1.173
	Birthplace not in US	-.509	.160	10.072	1	.002	.601	.439	.823
	Age 23-26 years	-.337	.102	10.786	1	.001	.714	.584	.873
	HL	.200	.248	.652	1	.420	1.221	.752	1.985
	Constant	-.086	.534	.026	1	.872	.918		

Note. [a]Variable(s) entered on step 1: Ethnicity_Race, EDUC1_CAT, English_Group, MARITAL_STATUS, FPL_Group, Birth, AGE_Cat22, HLL_BINARY

The multivariate logistic regression presented in Table 30 shows that HL level, health insurance, Pap smear experience, and worry about medical cost did not make a

significant contribution in predicting the outcome variable ($p > .05$). The AOR for HPV awareness slightly increased from 0.072 to 0.076 (95% CI 0.051, 0.112, $p < .001$). AOR for those who had not delayed getting medical care because of transportation also increased to 2.2 times more likely to receive the vaccine (95% CI 1.19, 4.10; $p = .012$). The AOR increased for participants who reported flu vaccine uptake in the past 12 months, AOR = 0.68 (95% CI 0.54, 0.84; $p < .001$).

Table 30

AOR of HPV Vaccine Uptake, Motivating Variables

		B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B)	
								Lower	Upper
Step 1[a]	HL, Below basic	-.073	.202	.132	1	.717	.929	.625	1.382
	HPV awareness (No)	-2.580	.200	165.631	1	.000	.076	.051	.112
	Health insurance (No)	-.186	.163	1.306	1	.253	.830	.603	1.142
	Region (Northeast)			12.646	3	.005			
	Region (Midwest)	-.275	.176	2.429	1	.119	.760	.537	1.073
	Region (South)	-.555	.162	11.684	1	.001	.574	.418	.789
	Region (West)	-.394	.168	5.480	1	.019	.674	.485	.938
	Flu vaccine (No)	-.392	.111	12.425	1	.000	.676	.544	.840
	Pap history (No)	-.140	.115	1.465	1	.226	.870	.694	1.090
	Transportation (No)	.791	.316	6.250	1	.012	2.205	1.186	4.099
	Medical cost (Not worried)	-.192	.127	2.291	1	.130	.825	.643	1.058
	Constant	.842	.161	27.173	1	.000	2.321		

Note. [a]Variable(s) entered on step 1: HLL_BINARY, HPV_Awareness, Health_Insurance, REGION, Flu_vaccine, Pap_History, Transportation, Medical_Cost.

Table 31 is a presentation of the AORs for sociodemographic and modulating variables without their interaction effects.

Table 31

AOR of HPV Vaccine Uptake, All Variables

		B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B)	
								Lower	Upper
Step 1[a]	HLL (Below basic)	-.088	.294	.090	1	.764	.916	.514	1.630
	HPV awareness (No)	-2.618	.207	160.394	1	.000	.073	.049	.109
	Health insurance (No)	-.037	.172	.045	1	.831	.964	.688	1.350
	Region (Northeast)			10.398	3	.015			
	Region (Midwest)	-.294	.184	2.558	1	.110	.745	.520	1.069
	Region (South)	-.535	.169	9.979	1	.002	.585	.420	.816
	Region (West)	-.346	.177	3.817	1	.051	.708	.501	1.001
	Flu vaccine (No)	-.405	.115	12.448	1	.000	.667	.532	.835
	Pap history (No)	-.627	.138	20.716	1	.000	.534	.408	.700
	Transportation (No)	.880	.328	7.200	1	.007	2.411	1.268	4.586
	Medical cost (Not worried)	-.038	.133	.082	1	.774	.963	.741	1.249
	AGE_P	-.190	.026	51.979	1	.000	.827	.785	.871
	Ethnicity (European American)			2.897	4	.575			
	Ethnicity (Hispanic American)	.105	.166	.400	1	.527	1.111	.802	1.537
	Ethnicity (African American)	-.108	.159	.460	1	.498	.898	.657	1.226
	Ethnicity (Asian American)	.047	.278	.029	1	.865	1.048	.608	1.808
	Ethnicity (Multiracial)	.493	.379	1.691	1	.193	1.638	.779	3.446
	Education (Bachelor's)			13.229	4	.010			
	< HS	-.465	.271	2.930	1	.087	.628	.369	1.070
	HS/GED	-.590	.164	13.014	1	.000	.554	.402	.764
	Some college	-.331	.150	4.851	1	.028	.718	.535	.964
	Associate	-.303	.202	2.250	1	.134	.739	.497	1.097
	Marital status (Married)			6.792	2	.034			
	Never married	.363	.148	6.029	1	.014	1.437	1.076	1.920
	Divorced, separated, widowed	-.053	.387	.019	1	.890	.948	.444	2.024

	B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
Income (≥ 300% FPL)			7.624	4	.106			
< 100%FPL_	-.200	.164	1.488	1	.223	.819	.594	1.129
100%-200% FPL	-.399	.169	5.591	1	.018	.671	.482	.934
200%-300% FPL	-.386	.169	5.196	1	.023	.680	.488	.947
Other	-.245	.185	1.751	1	.186	.783	.545	1.125
English, ,not proficient	.033	.323	.011	1	.918	1.034	.549	1.947
Not born in the US	-.356	.189	3.570	1	.059	.700	.484	1.013
Constant	5.495	.697	62.150	1	.000	243.490		

Note. [a.]Variable(s) entered on step 1: HLL_BINARY, HPV_Awareness, Health_Insurance, REGION, Flu_vaccine, Pap_History, Transportation, Medical_Cost, AGE_P, Ethnicity_GROUP, EDUC1_CAT, MARITAL STATUS, FPL_Group, English_Group, Birth.

Model With Interaction Effects

In a forced logistic regression that included 1,846 respondents representing 88.1% of the total sample, Table 32 shows how the DV of HPV vaccine status was recoded. For the survey question, “Have you ever received an HPV shot or vaccine?” individuals who responded “No” were coded 0, and all “Yes” responses were coded 1. Table 33 shows that the model itself explained 56.8% of the variance.

Table 32

DV Encoding

Original value	Internal value
No	0
Yes	1

Table 33

Variance Explained by the Model

	Observed		Predicted		
			HPV vaccine status		% correct
			No	Yes	
Step 0	HPV vaccine status	No	1,048	0	100.0
		Yes	798	0	.0
	Overall %				56.8

Note. Constant was included in the model. The cut value was .500

The output, as depicted in the Omnibus Tests of Model Coefficient (see Table 34), indicated that the overall fit of the model was significant: $\chi^2(62) = 489.14$, $p < .001$. The Hosmer and Lemeshow Test, $\chi^2(8) = 14.23$, $p = .076$, was not significant, indicating that the model was more predictable.

Table 34

Omnibus Tests of Model Coefficients

		Chi-square	*df*	Sig.
Step 1	Step	489.135	62	.000
	Block	489.135	62	.000
	Model	489.135	62	.000

The Nagelkerke R^2 value in Table 35 shows that the predictor variables explained 31.2% of the variance. The predictor variables improved the overall predictability of the model from 56.8% to 70.7% (see Table 36).

Table 35

Model Summary

Step	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
1	2036.003[a]	.233	.312

Note. [a] Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

Table 36

Variance Explained by HPV Vaccine Status

	Observed		Predicted		
			HPV vaccine status		% correct
			No	Yes	
Step 1	HPV vaccine status	No	752	296	71.8
		Yes	244	554	69.4
	Overall %				70.7

Note: The cut value was .500

Table 37 shows the AORs model, which accounted for all variables and their significant interaction effects. The AOR for HPV awareness remained the same (AOR = 0.072; 95% CI 0.045, 0.11, $p < .001$). The OR of whether a participant who was born outside the United States would receive the HPV vaccine also decreased to AOR = 0.32 (95% CI 0.13, 0.74; $p = .008$). AOR for Pap smear experience was attenuated (AOR = 0.55; 95% CI 0.41, 0.72). AOR for flu vaccine uptake slightly improved to 0.68 (95% CI 0.56, 0.85; $p = .001$). The AOR of delaying medical services because of the lack of transportation increased (AOR = 2.48; 95% CI 1.28, 4.84; $p = .008$). Adding the motivating variables attenuated the significance of almost all of the sociodemographic variables. The only exception was whether a participant was born inside or outside of the United States.

Table 37

AOR for HPV Vaccine Uptake

		B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B)	
								Lower	Upper
Step 1[a]	HLL(Below basic)	2.262	2.854	.628	1	.428	9.604	.036	2581.059
	HPV awareness (No)	-2.629	.211	155.814	1	.000	.072	.048	.109
	Health insurance (No)	-.052	.177	.086	1	.769	.949	.672	1.342
	Region (Northeast)			9.778	3	.021			
	Region (Midwest)	-.310	.188	2.706	1	.100	.733	.507	1.061
	Region (South)	-.535	.174	9.475	1	.002	.585	.416	.823
	Region (West)	-.331	.181	3.335	1	.068	.718	.503	1.025
	Flu vaccine (No)	-.391	.118	10.903	1	.001	.676	.536	.853
	Pap history (No)	-.605	.141	18.470	1	.000	.546	.414	.719
	Transportation (No)	.910	.340	7.149	1	.008	2.484	1.275	4.839
	Medical cost (Not worried)	.022	.136	.027	1	.869	1.023	.783	1.336
	AGE_	-.084	.055	2.351	1	.125	.919	.826	1.024
	Ethnicity (European American)			4.254	4	.373			
	Ethnicity (Hispanic American)	.122	.171	.509	1	.476	1.130	.808	1.580
	Ethnicity (African American)	-.142	.166	.733	1	.392	.868	.627	1.200
	Ethnicity (Asian American)	-.018	.286	.004	1	.950	.982	.560	1.722
	Ethnicity (Multiracial)	.611	.389	2.464	1	.117	1.842	.859	3.952
	Education (Bachelor's)			3.214	4	.523			
	<HS	3.187	2.755	1.338	1	.247	24.208	.109	5356.808
	HS/GED	1.209	1.615	.560	1	.454	3.349	.141	79.309
	Some college	1.474	1.580	.871	1	.351	4.369	.198	96.578
	Associates	3.247	2.050	2.509	1	.113	25.711	.463	1428.906
	Marital status (Married)			.396	2	.820			
	Never married	-.069	.266	.067	1	.796	.933	.554	1.573
	Divorced, separated, widow	-.738	1.223	.364	1	.547	.478	.044	5.258
	Income level (≥ 300% FPL)			1.936	4	.747			
	<100% FPL	.774	1.877	.170	1	.680	2.168	.055	85.876
	100%-200% FPL	-.645	1.946	.110	1	.740	.525	.012	23.768
	200%-300% FPL	-1.914	1.985	.929	1	.335	.148	.003	7.226
	Other	.334	2.071	.026	1	.872	1.397	.024	80.975
	English (not proficient)	.017	.341	.003	1	.959	1.017	.521	1.987
	Birthplace (Not born in US)	-1.155	.437	6.977	1	.008	.315	.134	.742

	B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
AGE_P by HLL_BINARY(1)	-.109	.131	.693	1	.405	.897	.694	1.159
AGE_P * FPL_Group			4.146	4	.387			
AGE_P by FPL_Group(1)	-.086	.074	1.362	1	.243	.918	.795	1.060
AGE_P by FPL_Group(2)	-.014	.076	.033	1	.856	.986	.849	1.145
AGE_P by FPL_Group(3)	.064	.077	.687	1	.407	1.066	.916	1.241
AGE_P by FPL_Group(4)	-.069	.083	.696	1	.404	.933	.793	1.098
AGE_P * EDUC1_CAT			3.867	4	.424			
AGE_P by EDUC1_CAT(1)	-.109	.115	.890	1	.346	.897	.716	1.124
AGE_P by EDUC1_CAT(2)	-.078	.069	1.257	1	.262	.925	.807	1.060
AGE_P by EDUC1_CAT(3)	-.101	.068	2.211	1	.137	.904	.792	1.033
AGE_P by EDUC1_CAT(4)	-.154	.088	3.042	1	.081	.857	.721	1.019
EDUC1_CAT * FPL_Group			17.549	16	.351			
EDUC1_CAT(1) by FPL_Group(1)	-1.085	.910	1.424	1	.233	.338	.057	2.009
EDUC1_CAT(1) by FPL_Group(2)	-.928	.905	1.052	1	.305	.395	.067	2.329
EDUC1_CAT(1) by FPL_Group(3)	-1.931	.969	3.973	1	.046	.145	.022	.968
EDUC1_CAT(1) by FPL_Group(4)	-.973	.944	1.063	1	.303	.378	.059	2.403
EDUC1_CAT(2) by FPL_Group(1)	-.352	.502	.492	1	.483	.703	.263	1.881
EDUC1_CAT(2) by FPL_Group(2)	.252	.502	.253	1	.615	1.287	.481	3.442
EDUC1_CAT(2) by FPL_Group(3)	-.186	.480	.151	1	.698	.830	.324	2.127
EDUC1_CAT(2) by FPL_Group(4)	.735	.525	1.960	1	.161	2.086	.745	5.841
EDUC1_CAT(3) by FPL_Group(1)	.506	.446	1.286	1	.257	1.659	.692	3.977
EDUC1_CAT(3) by FPL_Group(2)	.973	.462	4.444	1	.035	2.647	1.071	6.542
EDUC1_CAT(3) by FPL_Group(3)	.156	.453	.119	1	.730	1.169	.481	2.841
EDUC1_CAT(3) by FPL_Group(4)	.970	.521	3.461	1	.063	2.638	.949	7.327

	B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
EDUC1_CAT(4) by FPL_Group(1)	-.460	.648	.504	1	.478	.631	.177	2.247
EDUC1_CAT(4) by FPL_Group(2)	.430	.582	.547	1	.460	1.538	.491	4.814
EDUC1_CAT(4) by FPL_Group(3)	-.677	.584	1.344	1	.246	.508	.162	1.596
EDUC1_CAT(4) by FPL_Group(4)	.993	.734	1.829	1	.176	2.700	.640	11.388
FPL_Group * MARITAL STATUS			5.063	8	.751			
FPL_Group(1) by MARITAL STATUS(1)	1.079	.536	4.052	1	.044	2.943	1.029	8.417
FPL_Group(1) by MARITAL STATUS(2)	1.676	1.393	1.447	1	.229	5.346	.348	82.062
FPL_Group(2) by MARITAL STATUS(1)	.212	.409	.268	1	.605	1.236	.554	2.758
FPL_Group(2) by MARITAL STATUS(2)	1.021	1.420	.517	1	.472	2.776	.172	44.885
FPL_Group(3) by MARITAL STATUS(1)	.346	.426	.657	1	.417	1.413	.613	3.260
FPL_Group(3) by MARITAL STATUS(2)	-19.329	20153.967	.000	1	.999	.000	.000	.
FPL_Group(4) by MARITAL STATUS(1)	.562	.531	1.120	1	.290	1.754	.620	4.964
FPL_Group(4) by MARITAL STATUS(2)	.745	1.609	.214	1	.643	2.106	.090	49.315
Birth * MARITAL STATUS			4.381	2	.112			
Birth(1) by MARITAL STATUS(1)	.959	.461	4.322	1	.038	2.608	1.056	6.438
Birth(1) by MARITAL STATUS(2)	.510	1.305	.153	1	.696	1.665	.129	21.480
Constant	3.411	1.375	6.153	1	.013	30.290		

Note. [a.] Variable(s) entered on step 1: HLL_BINARY, HPV_Awareness, Health_Insurance, REGION, Flu_vaccine, Pap_History, Transportation, Medical_Cost, AGE_P, Ethnicity_GROUP, EDUC1_CAT, MARITAL STATUS, FPL_Group, English_Group, Birth, AGE_P * HLL_BINARY , AGE_P * FPL_Group , AGE_P * EDUC1_CAT , EDUC1_CAT * FPL_Group , FPL_Group * MARITAL STATUS , Birth * MARITAL STATUS .

A**ddressing the Confounding Variables**

Instrumental Variables and Predicted Residuals

I used the two-stage residual inclusion technique to account for endogeneity of the computed HL level and control for the confounding variables of ethnicity, education, income level (FPL), age, language, marital status, and country of birth. In the two-stage approach, I conducted the first regression on the proxy variable, HL, using the instrumental or confounding variables to estimate a predicted residual term. Tables 38 and 39 show the variables that were entered to estimate the predicted residual term, and the coefficients, respectively.

Table 38

Variables Entered/Removed

Model	Variables entered	Variables removed	Method
1	FPL, Place of birth, Marital Status Group, Age Group Category, Ethnicity-Race, Education 1 Category, English Language[b]	.	Enter

Note. DV: Derived HL level.
All requested variables entered.

Table 39

Instrumental Variables to Estimate HL

Model		Unstandardized coefficients		Standardized coefficients	*t*	Sig.
		B	*SE*	Beta		
1	(Constant)	228.560	2.950		77.482	.000
	Age group category	2.808	.520	.063	5.401	.000
	Education 1 category	8.013	.197	.488	40.689	.000
	English language	4.765	1.204	.051	3.958	.000
	Ethnicity-Race	-9.871	.250	-.462	-39.435	.000
	Place of birth	-5.942	.723	-.108	-8.223	.000
	Marital status group	3.119	.330	.110	9.457	.000
	FPL	3.319	.169	.228	19.681	.000

Note. DV: Derived HL Level

The predicted residual term generated in the first-stage regression was included as an additional regressor in the second multivariate regression model together with the motivating variables of HPV awareness, flu vaccine history, pap smear experience, region, transportation, and medical cost to generate the final model. Table 40 shows the final model with the predicted residual value (RES_1) as an additional variable.

Table 40 shows that the OR of HL was attenuated, after controlling for the confounding variables (AOR = 1.14; 95% CI 0.74, 1.75; $p > .05$, not significant). Experience with Pap smear and health insurance coverage status did not significantly predict the outcome variable. Other sociodemographic and motivating variables (i.e., ethnicity, history of flu vaccine uptake, HPV awareness, transportation, and region of residence [Northeast, South, and West]) were strong significant predictors of HPV vaccine uptake. Individuals with no history of flu vaccine uptake in the past 12 months were 32.1% less likely than those who reported flu vaccine uptake to initiate the HPV vaccine (AOR = 0.68; 95% CI 0.54, 0.85; $p < .001$). Participants who had never heard of

HPV were 92.1% less likely to have had received the vaccine (AOR = 0.079, 95% CI 0.05, 0.12; $p < .001$). Participants who reported that they had ever delayed medical care because of the lack of transportation were 2.3 times more likely to have received the HPV vaccine, compared to those without transportation problems(AOR = 2.26; 95% CI 1.21, 4.22; $p = .010$). The AOR for Hispanic American participants attenuated to 0.34 (95% CI 0.20, 0.56; p < .001). After controlling for the confounding variables, African American participants became highly significant in predicting the vaccine status (AOR = 0.50; 95% CI 0.34, 0.74; $p = .001$).

Table 40

AORs for HPV Vaccine Uptake

		B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B)	
								Lower	Upper
Step 1[a]	HPV awareness (No)	-2.537	.202	158.256	1	.000	.079	.053	.117
	Health insurance (No)	-.125	.167	.565	1	.452	.882	.636	1.223
	Region (Northeast)			12.075	3	.007			
	Region (Midwest)	-.327	.179	3.349	1	.067	.721	.508	1.024
	Region (South)	-.562	.164	11.701	1	.001	.570	.413	.787
	Region (West)	-.404	.171	5.585	1	.018	.667	.477	.933
	Flu vaccine (No)	-.387	.112	11.920	1	.001	.679	.545	.846
	Pap history (No)	-.113	.117	.926	1	.336	.893	.710	1.124
	Transportation (No)	.816	.319	6.550	1	.010	2.261	1.211	4.224
	Medical cost (Not worried)	-.133	.129	1.066	1	.302	.875	.680	1.127
	HL (Below basic)	.127	.220	.331	1	.565	1.135	.737	1.749
	Ethnicity (European American)			22.359	4	.000			
	Ethnicity (Hispanic American)	-1.091	.258	17.855	1	.000	.336	.203	.557

	B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
Ethnicity (African American)	-.686	.199	11.894	1	.001	.503	.341	.744
Ethnicity (Asian American)	.500	.285	3.072	1	.080	1.649	.943	2.886
Ethnicity (Multiracial)	1.332	.416	10.246	1	.001	3.788	1.676	8.563
RES_1	-.047	.010	20.786	1	.000	.954	.935	.974
Constant	1.096	.175	39.411	1	.000	2.991		

a. Variable(s) entered on step 1: HPV_Awareness, Health_Insurance, REGION, Flu_vaccine, Pap_History, Transportation, Medical_Cost, HLL_BINARY, Ethnicity_Race, RES_1.

Stratification by HL Level

Table 41 shows a multivariable logistic regression that stratified the variables by HL levels. HPV awareness was the only significant predictor variable for the participants with an HL level below basic. In contrast, HPV awareness, region of residence, history of flu shot, and transportation barriers significantly predicted HPV vaccine uptake among those with an HL level above basic.

Table 41

AOR of HPV Vaccine Uptake Stratified by HL Level

	Below-basic HL level				Above-basic HL level			
		95% CI for Exp(B)				95% CI for Exp(B)		
Variables	Exp(B)	Lower	Upper	*p* value	Exp(B)	Lower	Upper	*p* value
HPV awareness								
Yes	Reference				Reference			
No	.054	.017	.169	< .001	.079	.052	.120	<.001
Health insurance coverage								
Yes	Reference				Reference			
No	.894	.363	2.202	.808	.830	.588	1.171	.289
Region								
Northeast	Reference			.325	Reference			.011
Midwest	.743	.169	3.270	.694	.766	.536	1.095	.144
South	.326	.081	1.308	.114	.585	.421	.811	.001
West	.521	.129	2.096	.358	.677	.481	.952	.025

	Below-basic HL level				Above-basic HL level			
		95% CI for Exp(B)				95% CI for Exp(B)		
Variables	Exp(B)	Lower	Upper	*p* value	Exp(B)	Lower	Upper	*p* value
Flu vaccine uptake								
Yes	Reference				Reference			
No	.716	.296	1.736	.460	.666	.532	.835	< .001
Pap smear experience								
Yes	Reference				Reference			
No	1.383	.575	3.329	.469	.844	.667	1.069	.159
Healthcare delay, transportation								
Yes	2.621	.411	16.722	.308	2.075	1.068	4.032	.031
No	Reference				Reference			
Medical cost								
Worried	.534	.226	1.261	.153	.858	.659	1.117	.254
Not worried	Reference				Reference			

Summary

Statistical analysis of the data led to the rejection of the null hypothesis (H_{01}) which stated that there is no significant relationship between HL and HPV vaccine uptake among racial minority young adult women. The analysis showed lack of multicollinearity in the data and the underlying statistical assumption of linearity of logit was met for the HLL. The results showed significant associations between HLL and HPV vaccine uptake. HL did not independently predict the likelihood of an individual to initiate the HPV vaccine. The relationships between the motivating variables, however, were mediated by the HL level. The relationship between ethnicity and the HPV vaccine uptake was completely mediated by the HL level. The results showed that health literacy was a strong determinant of HPV vaccine intention, among the young adult women.

Preview of the Chapter 5

It is important to compare the findings from this study with extant knowledge and provide possible explanation of any discrepancy. The following chapter will present the discussion of the results and implications of the findings, offer recommendations, and discuss the social change associated with this study.

Chapter 5: Discussion, Implications, Recommendations, and Conclusion

Previous research on the low HPV vaccine uptake among adolescents and young adult women placed the focus on individual variables such as ethnicity, income levels, highest educational attainment, attitudes toward vaccination, and concerns about vaccine safety and efficacy. To address the gap in the literature, I conducted this study to evaluate the relationship between each of the two main IVs, ethnicity and HL, and the DV of HPV vaccine uptake. A bivariate statistical analysis showed that individuals with an HL level below basic were 47.3% less likely to consider HPV vaccine uptake than people with an HL level above basic. After introducing HLL into the statistical model, ethnicity became a significant predictor of the HPV vaccine status for the Hispanic American and African Americans participants, but not the European American participants. A multivariable logistic regression analysis showed that HL level did not independently predict the vaccine uptake among the young adult women. Stratification by HL level revealed that an HL level above basic was a strong determinant of HPV vaccination intention and that it actively mediated the relationships between the motivating variables and the outcome variable.

Interpretation of Findings

Ethnicity

The final analysis of the data involved 1,846 (88.1%) noninstitutionalized, civilian, female participants, ages 18 to 26 years, who were living in the United States at the time of the study. Results showed the existence of racial disparity in HPV vaccine uptake among young adult women. Results from this nationally representative sample

were consistent with the literature that minority women are less likely to initiate the HPV vaccine than their European American counterparts (Burger et al., 2016; Gelman et al., 2013; Okafor, Hu, & Cook, 2015).

Analysis of the data indicated that African American women, ages 18 to 26 years, had 50% lower OR to report having had an HPV vaccine, compared with their European American counterparts. This result was much higher than the findings by Daniel-Ulloa et al. (2016), who reported that African American women were 30% less likely to initiate the HPV vaccine. The different ORs might have been due to the additional age groups in Daniel-Ulloa et al.'s study, in which the researchers analyzed data on female participants, ages 18 to 30 years. The inclusion of individuals between the ages of 27 and 30 years might have contributed to the attenuation of the OR for the young African American women. Similar to the African American female participants, the young adult Hispanic American women had lower OR of receiving the HPV vaccine (OR = 0.60; 95% CI 0.48. 0.76; $p < .001$) than their European American counterparts. After adjusting for the confounding instrumental variables in the presence of the motivating variables, the OR for the young adult Hispanic American participants for initiating the vaccine decreased from 0.60 to 0.34 (AOR = 0.34; 95% CI 0.20, 0.56; $p < .001$).

Among the vaccinees, 48.8% were European American, 25.8% were Hispanic American, and 17.2% were African American participants. These rates were consistent with the systematic review findings by Bakir and Skarzynski (2015), who reported vaccination rates among medically underserved minority women to be about 24%. The vaccination rate for the African American women was consistent with the 2008-2012

HPV vaccination rate of 15.5% for non-Hispanic African American females (S. Schmidt & Parsons, 2014). The observed rates in this study, on the contrary, were not consistent with other studies, positing that racial minorities were equally or more likely to initiate HPV vaccine uptake (Jeudin et al., 2014). The difference between the reported initiation rates might have been attributed to the different demographic groups, that is adolescents (13-17 years) and young adults (18-26 years), used in the studies. The vaccine initiation rate and the OR in this analysis for the African American female participants were consistent with the initiation rate and OR reported by Okafor et al. (2015) in a study that recruited 835 college women, ages 18 to 26 years, from the University of Florida. Okafor et al.'s findings did not reach statistical significance for the Hispanic American participants.

Health Literacy

Analysis of data involving 1,940 of the participants showed a significant relationship between HL level and HPV vaccine uptake. A two-stage residual inclusion technique was used to control for endogeneity in the derived HL scores. Thus, I obtained a predicted residual term in the first-stage regression on the derived HL scores by using the instrumental variables of age, education level, marital status, income level, ethnicity, and language spoken. I added the predicted residual term (RES_1) to the model as an additional regressor in the second-stage multivariable models.

Individuals with HL levels that were below basic had a 0.50 lower OR of initiating the HPV vaccine than those with HL levels that were above basic (95% CI 0.35, 0.70; $p < .001$). This result was consistent with previous studies that identified the

positive association between low HL and untoward health behaviors or health outcomes (Apolinario et al., 2015; Cha et al., 2014; Hoover et al., 2015; Olin et al., 2010; Veldwijk et al., 2015). Unfortunately, the racial minority population in this study was disproportionately burdened by inadequate HL levels, confirming the findings from Kutner et al.'s (2003) study. Of the 190 (9.1%) participants in the survey with HL scores below basic, 68.9% were Hispanic Americans, and 30.5% were African Americans. All of the European American participants demonstrated HL levels that were above basic. Survey respondents with HL scores that were above basic were 58.0% European Americans, 18.2% Hispanic Americans, and 15.2% African Americans (see Appendix A).

Results of the data analysis indicated that individuals in the group that had HL levels below basic were 26.6% more likely to report no receipt of the HPV vaccine (Relative Risk [RR] = 1.266; 95% CI 1.14, 1.41) and 33.3% less likely to have received the vaccine (RR = 0.67, 95% CI 0.53, 0.84). The findings are consistent with the body of knowledge showing that inadequate HL levels are associated with poor health outcomes in cancer prevention behaviors. Using the level of education as a measure of HL, Lindau et al. (2002) identified low HL as a significant predictor of cervical cancer screening knowledge. Sentell, Braun, Davis, and Davis (2013) assessed HL by evaluating the level of difficulty at which participants understood doctors' written information and ability to understand information on prescription bottles. They concluded that HL levels were associated with colorectal cancer screening.

Subgroup Data Analysis: Minority Participants

A subgroup analysis involving only minority participants, that is, 485 (58.2%) Hispanic American and 349 (41.2%) African American women, showed no significant difference regarding HPV vaccine uptake. Among the minority women, Hispanic American participants had lower OR of receiving the HPV vaccine (OR = 0.77; 95% CI 0.57, 1.03; $p = .08$) when compared to their African American counterparts. After adjusting for HL in the subgroup, ethnicity became highly significant in predicting HPV vaccine uptake, and the OR attenuated from 0.77 to 0.57. Thus, the young minority Hispanic American women were 43% less likely than the African American women in the study to report receiving the vaccine. Results showed that HL levels mediated the relationship between ethnicity and HPV vaccine uptake, consistent with previous studies (Ayotte, Allaire, & Bosworth, 2009; Howard, Sentell, & Gazmararian, 2006).

A multivariable logistic regression analysis that included the motivating variables showed that history of flu vaccine uptake, perception of good or fair physical health status, HPV awareness, and region of residence (Northeast and South only) were strong predictors of HPV vaccine uptake among the participants. Health insurance coverage, HL, Pap smear history, region of residence (West and Midwest), medical cost, and transportation barriers did not significantly predict HPV vaccine uptake among the minority subgroup.

Model With the Motivating Variables

Analysis of the data showed significant associations between HL levels and the variables of perceived health status (χ^2 [4] = 33.76, $p < .001$); health insurance coverage

(χ^2 [1] = 52.04, $p < .001$); HPV awareness (χ^2 [1] = 51.79, $p < .001$); and ethnicity (χ^2 [4] = 344.20, $p < .001$). These results were consistent with extant knowledge. The associations between HL levels and health insurance coverage and access to preventive health care services were consistent with previous studies (Levy & Janke, 2016; National Academies of Sciences, Engineering, 2016; Scott, Gazmararian, Williams, & Baker, 2002). Previous research has found that individuals with inadequate HL are more likely to have limited knowledge of their chronic diseases (Davey, Holden, & Smith, 2015; Gazmararian, Williams, Peel, & Baker, 2003; Poureslami, Nimmon, Rootman, & Fitzgerald, 2016; M. V. Williams, Baker, Parker, & Nurss, 1998). Guerra and Shea (2007) reported no association between functional HL levels and perceived health status among ethnic minorities, whereas other researchers have documented the association between low HL levels and poor self-perceived health status (Amoah, Phillips, Gyasi, Koduah, & Edusei, 2017; Kamran, Sharifirad, Shafaeei, & Mohebi, 2015; Lee et al., 2010; Toci et al., 2015).

The significance of flu vaccine history in predicting HPV vaccine initiation was consistent with previous literature (Du et al., 2015; Lupattelli et al., 2014; Price et al., 2011). HPV knowledge in my study was a strong predictor of vaccine initiation, a finding that was consistent with other studies (Fernández, Le, Fernández-espada, Aragon, & Colón-lópez, 2014; Kester, Shedd-Steele, Dotson-Roberts, Smith, & Zimet, 2014; Marchand et al., 2012; Massad et al., 2015; Strohl et al., 2015).

The Pap smear OR from this study was inconsistent with Rositch et al.'s (2012) conclusion that a history of Pap smear increased the OR of cervical cancer prevention.

The discordance in the findings might have been the result of the participants' health status. Rositch et al. recruited only HIV-positive patients in their study, possibly influenced by medical surveillance bias. The lack of statistical significance, however, agreed with more recent studies.

Laz, Rahman, and Berenson (2013), who also used 2010 NHIS data from 2010, found a positive association between Pap smear history and HPV vaccine uptake. The difference in the reported significance of Pap smear as a predictive variable might have been the result of the recent decline in Pap smear testing among females ages 18 to 20 year. According to Polcari and Hecht (2017), the 2012-2014 Behavioral Risk Factor Surveillance System showed a decrease in Pap smear testing among females ages 18 to 20 years from 36.8% to 27%.

In my study, a history of Pap smear was not a significant predictor of HPV vaccine initiation among young adult women. A similar finding was noted in the subgroup data analysis that included only the African American and Hispanic American women. The finding is consistent with recent literature that has not found statistical significance between Pap smear history and HPV vaccine initiation (Canfell et al., 2015; Charakorn et al., 2011). Parental Pap smear screening history, however, has been associated with adolescent daughters' vaccine uptake (Chao, Slezak, Coleman, & Jacobsen, 2009; Lefevere et al., 2011; Lutringer-Magnin et al., 2013; Monnat & Wallington, 2013).

Some researchers have found a significant association between health insurance coverage and HPV vaccine uptake (Price et al., 2011; S. Schmidt & Parsons, 2014). The

multivariable analysis in the current study, however, did not find health insurance coverage to be a significant predictor of vaccine uptake among the minority population. Marchand et al. (2012) did not find a significant association between health coverage status and HPV vaccine uptake. One of the reasons for the discordance might have been the approaches used in measuring the health insurance coverage in each study. Cowburn et al. (2014) measured participants' insurance coverage by categorizing the percentage of time that the individual was insured during the study period. The researchers identified lower odds of HPV vaccination for individuals who were insured less than 66% of the study period. Cowburn et al.'s findings indicated that an association with the cross-sectional measurement of the insurance coverage might have been misleading. Since enactment of the Affordable Care Act (ACA) of 2010, most private health insurance companies have provided full coverage of the HPV vaccine, with no out-of-pocket cost or deductible (CDC, 2013; Lipton & Decker, 2015). Thus, the effect of health insurance coverage on vaccine uptake might have been mediated by enactment of ACA and the adjustment of health insurance policies.

The data analysis on the full sample showed that U.S. region (i.e., Northeast, South, and West) of residence was statistically significant in predicting HPV vaccine initiation for participants. However, subgroup analysis on the African American and Hispanic American women showed that only the Northeastern and South regions were significant predictors of the outcome variable. Much of the literature has identified a lack of geographical disparities in HPV vaccine uptake (Laz, Rahman, & Berenson, 2013; Wisk, Allchin, & Witt, 2014), but S. Schmidt and Parsons (2014) noted that the region of

residence was a significant predictor of interest in the HPV vaccine. S. Schmidt and Parson found that geographic HPV vaccination disparity was based on 2008-2010 NHIS data, whereas this study was based on 2015 data from the NHIS.

Between 2006, when the FDA approved the HPV vaccine, and 2015 (this study's survey year), many states have introduced or enacted policies and bills to address certain environmental barriers to HPV vaccine uptake (Keim-Malpass, Mitchell, DeGuzman, Stoler, & Kennedy, 2017). With the exception of Alabama, Delaware, Idaho, Montana, New Hampshire, and Wyoming, states that have not introduced any HPV vaccination-related legislation, the other 44 states and the District of Columbia have at least introduced bills to either mandate the vaccine, provide funding for the vaccination, create awareness about the vaccine, or provide private-public funding for vaccination programs (Keim-Malpass et al., 2017). Such state-level initiatives address some of the environmental barriers, making them less significant in predicting vaccination status.

Many studies have identified health care cost or cost of vaccines as a barrier to HPV vaccine uptake (Btoush, Brown, Fogarty, & Carmody, 2015; Holman et al., 2014; Lechuga, Swain, & Weinhardt, 2011; Luque et al., 2012; Patel et al., 2012). Results of the current study did not identify worries about medical cost as a significant determinant of HPV vaccine initiation, a finding consistent with other studies, in which free HPV vaccination did not improve the vaccine's initiation rate (Casey et al., 2013; Fernández, Le, Fernández-espada, Aragon, & Colón-lópez, 2014). In terms of transportation, I did not find a significant association between transportation barriers and vaccine initiation. Similar results had been reported in the literature (Thompson, Arnold, & Notaro, 2011).

A bivariate analysis focused solely on minority (African American and Hispanic American) women. For 755 (90.5%) of the participants, 79 (9.5%) missing indicated that HL has a strong relationship with the HPV vaccine initiation among the participants. Participants with HL levels that were below basic were 36.3% less likely to report having received the HPV vaccine than participants with HL levels above basic. HL level was not independently associated with HPV vaccine uptake among the participants when considering the potential motivational variables.

Analysis: Conceptual Framework

The IBM identifies behavioral intention as the most important determinant to perform behaviors. The model, however, posits that behavioral intention without the appropriate motivational factors might not necessarily lead to performance of the recommended behaviors (Glanz et al., 2008). For individuals to act on strong behavioral intention, there is the need to have knowledge about the behaviors, prior experience with the behaviors, and little to no environmental barriers. In addition, the behaviors should be salient. Many studies have established that levels of HL are significantly associated with vaccine uptake intention (Aharon et al., 2017; Ratzan, 2011; Veldwijk et al., 2015; M. S. Williams, 2014).

In the current study, key motivational variables were included in the model to assess their effects on the behavioral intention determinant of HL levels. Participants' HPV knowledge or awareness was included to assess how knowledge of HPV motivated the individuals to act on the behavioral intention (HL). Participants' history of flu shot and Pap smear also were included to assess the influence of habitual control and salience

of behavior, respectively, on HL levels. Delay of medical care resulting from the lack of transportation, worries about medical cost, and region of residence were included to evaluate environmental constraints that could have affected the participants' ability to act on intention.

A chi-square analysis showed a strong significant association between HL levels and HPV vaccine uptake among the minority women. Multivariable logistic regressions conducted on the full sample and the minority women separately were to identify motivational variables that could have influenced to the decision to carry out the vaccination behavioral intention. Sociodemographic variables of age, ethnicity, marital status, and income level (100%-200% FPL), and motivating variables of HPV knowledge or awareness, region of residence (Northeast and South), flu shot history, and Pap smear history were significant predictors of HPV vaccine uptake (see Appendices B & C). Conversely, a multivariable regression analysis on the full sample that included HL as a regressor was not significantly different from the model without HL (see Appendix D).

A multivariate logistic regression on the full sample revealed that inclusion of HL levels in the model attenuated the ORs of flu shot and Pap smear history and augmented the ORs of age, marital status (never married and married), and income level (200%-300% FPL). In the full sample analysis, ethnicity was highly significant in predicting HPV vaccine uptake when HL is included in the model. A separate multivariate logistic regression analysis involving only the African American and Hispanic American women showed that HL levels augmented the ORs of age, marital status (never married), and

income level (100%-200% FPL), and attenuated the ORs of history of flu shot and Pap smear experience.

Mediating Effects of Health Literacy

To ascertain the mediating effect of HL level on each motivating variable included in the model, several bivariate logistic regressions on the full sample that included HL and each of the motivating variables as regressors showed that ethnicity was highly significant in the presence of HL. Health insurance coverage, on the contrary, did not significantly predict HPV vaccine uptake after adjusting for HL levels. HL levels did not mediate the association between HPV knowledge and HPV vaccine uptake among the participants. HL augmented the ORs of flu vaccine history, region of residence (South), health care delay resulting from transportation barriers, and worries about medical cost; and decreased the ORs of Pap smear history.

A subgroup data analysis on the minority women (Hispanic Americans and African Americans) showed that the unadjusted OR of HL level was 0.64. In the presence of region of residence, however, the OR of HL level attenuated from 0.64 to 0.603 and health care delay resulting from transportation problem to 0.634. Other variables increased the OR of HL levels. For instance, the HL OR increased in the presence of flu shot history to 0.648, 0.659 in the presence of worry about medical cost, and 0.682 in the presence of health insurance coverage. Once the motivating variables were all added to the model in a forced multivariable logistic regression, HL levels no longer significantly predicted the probability of the outcome variable. Thus, HL levels did not independently predict the probability of the participants initiating HPV vaccine uptake.

Stratification by Health Literacy Levels

The analysis stratified by HL levels revealed that with the exception of HPV knowledge, none of the motivating variables included in the model significantly predicted the probability of HPV vaccine uptake among participants who had HL levels that were below basic. In contrast, HPV awareness, region of residence (Northeast, South, and West); history of flu shot; and transportation barriers were significant predictors of the DV for participants with HL levels that were above basic. Health insurance coverage was not a significant predictor of HPV vaccine uptake in both strata, a finding consistent with the literature (Cowburn et al., 2014; Levy & Janke, 2016; Ylitalo et al., 2013).

Results of this study confirmed those in previous studies by establishing that HL levels significantly predicted HPV vaccine uptake intention (Britt, Collins, Wilson, Linnemeier, & Englebert, 2015; Veldwijk et al., 2015). With adequate HL levels, the motivational variables of HPV awareness, flu shot history, Pap smear history, health insurance coverage, transportation barriers, region of residence, and worries about medical cost significantly predicted HPV vaccine uptake.

Summary

For the full sample, participants who reported vaccine uptake were more likely to be European American women between the ages of 18 and 26 years, had HL levels that were above basic, were married or had never married, fell between 200% and 300% of FPL, had heard of HPV, did not live in the Midwest, had had a Pap smear, and had a history of receiving flu vaccines. Similarly, the African American and Hispanic American women who reported HPV vaccine uptake were more likely to be younger (18-

22 years), had HL levels above basic, were married or had never married, fell between 100% and 200% FPL, lived in the Northeast or South region of the United States , had heard of HPV before, had prior experience with Pap smear, and had a history of flu vaccine uptake. HL levels above basic are a strong determinant of behavioral intention.

Strengths and Limitations

To the best of my knowledge, this study was first study to look beyond behavioral intentions and use a theoretical framework to consider possible variables that could motivate individuals to carry out behavioral intentions. I did not focus on female college students or women attending particular health care centers alone; instead, the NHIS recruiters used a multistage recruitment strategy to recruit more minorities. The study design and data collection helped to include members of the hard-to-reach minority population who might have been excluded in regular surveys. The results were not limited to particular regions; rather, they encompassed the entire United States.

Gelman et al. (2013) concluded that ethnicity does not explain HPV vaccination disparities. I found that the relationship between ethnicity and HPV vaccine uptake was completely mediated by HL levles. Thus, when HL levels were adjusted, ethnicity became a significant predictor of HPV vaccine uptake. This study also demonstrated the ability to compute HL scores using the sociodemographic variables of the existing data set.

The study had several limitations that might have affected the generalizability of the findings. Therefore, the result should be interpreted with caution and generalized only within the United States. The study did not establish the validity of the participants'

responses to the survey, leading to possible misinformation bias or misclassification. Crucial information about engagement in risky sexual behaviors and other activities that was not collected during the participants' interview limited the analysis and interpretation of the results. The self-reported vaccination status could have been influenced by social desirability bias or recall bias. Lack of triangulation of participants' responses might have introduced self-reporting bias and social desirability bias. Missing data on key valuable variables might have impacted the sample size, especially during data stratification.

The data were collected in 2015, so the findings might not reflect changes in the population that have occurred in the past t2 years. In terms of selecting participants, the complex, stratified, multistage area probability design might have introduced selection bias and influenced the observed association in the study. Although the model by Martin et al. (2009) provided a unique approach to compute HL levels, the predicted HL scores from the model might not have reflected the actual HL levels of the participants. Dichotomization of the HL scores could have led to information loss on HL levels. In addition, the full model, as described by Martin et al., included "Rurality" which was not available in the secondary data used in this study. Results might not be generalizable to countries other than the United States.

Recommendations

Future researchers should evaluate the mediation pathways of HL levels on the relationships between the motivating variables of HPV awareness, flu vaccine history, Pap smear history, health insurance coverage, transportation barriers, region of residence, and health care costs, and HPV vaccine uptake. The mediation effect of HL levels on

ethnicity and region of residence is not fully understood, so future researchers should focus on providing clarity to the relationships and identifying actionable variables that can help to reduce disparities in HPV vaccine uptake among minority populations.

Implications

Veldwijk et al. (2015) recommended that researchers of vaccination decision behavior consider HL levels of the target audience. The findings of this study provide clinicians and health care providers with a way to estimate the HL levels of their patients or the communities they serve by using the sociodemographic variables. Pinto et al. (2016) demonstrated the feasibility and acceptability of collecting sociodemographic data in primary care. Therefore, health care providers and public health practitioners could use the available sociodemographic data to compute HL levels to help to guide their practitioner-patient communication and health promotion initiatives. Although HL levels are a strong determinant of behavioral intention, the ability to perform the behaviors is influenced by motivational factors. Results of this study indicated that HPV knowledge, region of residence, past flu shot experience, Pap smear history, and transportation needs are important variables that are needed for individuals to act on the intention to vaccinate against HPV.

Health care practitioners and community members might consider acting on the findings by raising HPV awareness within their respective communities. The community-level awareness of HPV could be raised in different ways, including direct participation in local community events such as walk-a-thons; health fairs; screening events; and county fairs, where printed health material could easily be distributed. Other avenues

could include leaving brochures and posters at barber shops and beauty parlors; participating in community discussions; collaborating with social media application developers to display HPV-related materials on social media sites; and creating podcasts or PSAs to circulate on social media (CDC, 2012).

Another significant motivational factor identified in the study after adjusting for HL levels was region of residence. Apart from the participants in the Midwest region in the full sample analysis, place of residence could significantly have influenced the ability of young adult women to perform HPV vaccine initiation. The subgroup analysis on the African American and Hispanic American women showed that the Northeast and South regions were significant predictors, after adjusting for HL levels. Ethnic minorities are concentrated mostly in the South region and large cities in the Northeast: Mississippi, Louisiana, Georgia, Maryland, South Carolina, New York City, and the District of Columbia (U.S. Census Bureau, 2011). According to Brown and Lopez (2013), approximately 74% of the Hispanic American population live in Texas, Arizona, Florida, New Mexico, California, Illinois, New Jersey, and New York. Most of these states are in either the South region or the Northeast region of the United States. Unfortunately, historic events such as the legacy of racism, low levels of trust in the health care system, and the Tuskegee Syphilis Study have affected participation rates (Freimuth et al., 2001; Mokwunye, 2006; Moutsiakis & Chin, 2007; Wilkinson & Pickett, 2009).

Health care delay resulting from the lack of transportation was a significant environmental variable that could be addressed to promote vaccine uptake among young adult women. Policy-level interventions have had many successes, although challenges

and controversies remain (Brandt, Pierce, & Crary, 2016). In the United States, the formulating and enacting HPV vaccination policies are at the state level. Health care and public health practitioners might wish to use the findings, which indicate the significance of environmental factors on vaccine uptake, and initiate social marketing techniques such as media advocacy or grassroots advocacy groups to apply pressure on lawmakers for policy changes to remove environmental barriers and promote facilitating factors (Resnick & Siegel, 2013).

The result showed that individuals with a history of Pap smear or flu shot were more likely to act on behavioral intentions. Thus, practitioners might need to move upstream to promote yearly flu vaccine uptake and Pap smear among young adult women. Individuals with a history of flu shot or Pap smear would mostly develop the necessary salience of the vaccination behavior and habit of taking cancer preventive measures, respectively. The salience of behavior and experience in performing similar behavior might make the HPV vaccination seem habitual to individuals. For individuals with HL levels that are below basic, practitioners might develop specific culturally sensitive messages by highlighting the recommended behavioral exchanges and the expected benefits of the replacement behaviors to the individuals and by removing barriers that prevent or restrict their interactions with the health care system.

Social Change

Many previous studies evaluating the relationship between HL levels and HPV vaccination intention have used the TRA, TPB, or a merger of both theories. These two theories or their merger have been used to identify the relationships between HL levels

and vaccination intention (Bennett et al., 2012; Britt et al., 2015; Britt, Hatten, & Chappuis, 2014; Fisher, Kohut, Salisbury, & Salvadori, 2013; Patel et al., 2012; Ratanasiripong et al., 2013). However, research examining the relationship between HL levels and HPV vaccination intention has been very limited. The IBM, which is built upon the constructs of TRA and TPB and examines the motivating factors that can lead to the performance of actual behaviors, provided the conceptual framework to understand the factors that might facilitate or hinder strong HPV vaccination behavioral intentions.

This study adds to the body of knowledge in public health regarding the antecedents and consequences of HL levels about HPV vaccine uptake among underserved young adult women, ages 18 to 26 years, in the United States. Results of this study provide public health practitioners with information that will help them to accurately understand the factors that influence HPV vaccination intention as well as factors in the complex health care system that hinder or facilitate this population's ability to carry out the vaccination intention. Thus, this study might guide public health practitioners to influence policymakers to address environmental barriers and current health care policies. The study also identified important variables that can be addressed in health promotion initiatives to improve HPV vaccine uptake rates.

Conclusion

Results of the study confirmed the racial disparity in HPV vaccine uptake and that the relationship between ethnicity and vaccine uptake was completely mediated by HL levels. Although HL levels have a strong association with HPV vaccine uptake, HL does not independently predict the probability of young adult women initiating the vaccine.

HL levels that are above basic are a strong determinant of HPV vaccine uptake intention, and they are antecedent to the actual behavior. Individuals with HL levels below basic are less likely to have reported receiving the vaccine. HL mediates the relationships between motivating variables and HPV vaccine initiation.

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Appendix A: Health Literacy Composition

			Health literacy adequacy		Total
			Below basic	Above basic	
Ethnicity-Race	White	Count	0	1096	1096
		% within Ethnicity-Race	0.0%	100.0%	100.0%
		% within HL adequacy	0.0%	58.0%	52.7%
	Hispanic	Count	131	344	475
		% within Ethnicity-Race	27.6%	72.4%	100.0%
		% within HL adequacy	68.9%	18.2%	22.8%
	Black	Count	58	287	345
		% within Ethnicity-Race	16.8%	83.2%	100.0%
		% within HL adequacy	30.5%	15.2%	16.6%
	Asian	Count	0	125	125
		% within Ethnicity-Race	0.0%	100.0%	100.0%
		% within HL adequacy	0.0%	6.6%	6.0%
	Other races	Count	1	39	40
		% within Ethnicity-Race	2.5%	97.5%	100.0%
		% within HL adequacy	0.5%	2.1%	1.9%
Total		Count	190	1891	2081
		% within Ethnicity-Race	9.1%	90.9%	100.0%
		% within HL adequacy	100.0%	100.0%	100.0%

Appendix B: Adjusted OR of HPV Vaccine Uptake, Full Sample

	Model without health literacy level				Model with health literacy level			
n = 1855		95% CI for Exp (B)			*n* = 1846	95% CI for Exp(B)		
Variables	Exp(B)	Lower	Upper	*p* value	Exp(B)	Lower	Upper	*p* value
Age (years)								
18 - 22	Reference				Reference			
23-26	.529	.418	.670	< .001	.564	.443	.717	< .001
Ethnicity								
White	Reference			.577	Reference			.002
Hispanic	1.090	.795	1.495	.591	.206	.082	.514	.001
Black	.900	.663	1.221	.498	.357	.203	.631	< .001
Asian	.976	.569	1.671	.928	2.217	1.112	4.420	.024
Multiracial	1.665	.793	3.497	.178	5.918	2.200	15.924	.000
Highest education attainment								
< HS	.629	.404	.979	.040	1.003	.566	1.778	.991
HS/GED	.597	.435	.819	.001	1.012	.667	1.535	.957
Some college, no degree	.759	.567	1.017	.065	1.091	.771	1.542	.623
Associate	.790	.534	1.170	.240	.635	.421	.958	.030
>= Bachelor's	Reference			.028	Reference			.220
Marital status								
Never married	1.552	1.166	2.066	.003	1.729	1.287	2.324	< .001
Divorced, separated, widowed	.907	.427	1.928	.800	.901	.421	1.928	.787
Married	Reference			.005	Reference			.001
Poverty level, FPL								
< 100%	.822	.600	1.127	.224	.784	.568	1.081	.138
100 - 200%	.673	.485	.934	.018	.737	.528	1.028	.073
200 - 300%	.685	.493	.952	.024	.692	.497	.963	.029
Other	.782	.545	1.120	.180	.588	.397	.872	.008
>= 300%	Reference			.108	Reference			.059
Language								
English	Reference			.954	Reference			.149
Other language	0.982	.529	1.822		.138	0.138	0.138	
Place of birth								
US	Reference			.049	Reference			.758
Other country	0.693	.481	0.998		1.069	0.698	1.638	
HPV awareness								
Yes	Reference				Reference			
No	0.077	.052	0.115	< .001	.075	.050	.112	< .001

	Model without health literacy level				Model with health literacy level			
n = 1855		95% CI for Exp (B)			*n* = 1846	95% CI for Exp(B)		
Variables	Exp(B)	Lower	Upper	*p* value	Exp(B)	Lower	Upper	*p* value
Health insurance coverage								
Yes	Reference				Reference			
No	0.961	.689	1.340	.813	.962	0.688	1.346	.823
Region								
Northeast	Reference			.011	Reference			.013
Midwest	0.742	.519	1.060	.101	.726	0.507	1.039	.080
South	0.578	.416	0.803	.001	.579	0.416	.806	.001
West	0.707	.502	0.997	.048	.694	0.492	.980	.038
Flu vaccine uptake								
Yes	Reference				Reference			
No	0.666	0.533	0.833	< .001	.654	.522	.819	< .001
Pap smear experience								
Yes	Reference				Reference			
No	0.650	0.504	0.839	.001	0.636	0.492	.822	.001
Healthcare delay, transportation								
Yes	2.396	1.274	4.506	.007	2.357	1.242	4.470	.009
No	Reference				Reference			
Medical cost								
Worried	0.920	.711	1.190	.524	0.955	0.736	1.239	.728
Not worried	Reference				Reference			
Health Literacy								
Below basic					0.917	0.516	1.630	.767
Above basic					Reference			

Appendix C: Adjusted OR of HPV Vaccine Uptake, Minority

n = 723	Model without health literacy level				Model with health literacy level *n* = 714			
		95% CI for Exp (B)				95% CI for Exp (B)		
Variables	Exp (B)	Lower	Upper	p-value	Exp (B)	Lower	Upper	*p*-value
Age (years)								
18 - 22	Reference				Reference			
23-26	.448	.302	.665	<0.001	.490	.327	.734	0.001
Ethnicity								
White								
Hispanic	Reference				Reference			
Black	1.019	.665	1.560	0.933	2.113	.940	4.750	0.070
Asian								
Multiracial								
Highest Education Attainment								
< High school	.569	.290	1.118	0.102	.806	.291	2.230	.678
High school / GED	.673	.368	1.228	0.197	1.147	.507	2.595	.742
Some college, no degree	.947	.534	1.682	0.854	1.398	.716	2.732	.326
Associate	1.162	.537	2.518	0.703	.991	.448	2.191	.982
>= Bachelors	Reference			0.227	Reference			0.690
Marital status								
Never married	2.054	1.167	3.614	0.013	2.200	1.218	3.974	.009
Divorced, separated, widowed	.620	.156	2.461	0.496	.569	.142	2.286	.427
Married	Reference			0.012	Reference			0.007
Poverty level, FPL								
< 100%	.599	.326	1.101	.099	.559	.295	1.057	.073
100 -200%	.386	.198	.751	.005	.435	.221	.858	.016
200- 300%	.607	.314	1.172	.137	.615	.319	1.187	.147
Other	.637	.332	1.220	.173	.490	.241	.999	.050
>= 300% FPL	Reference			0.090	Reference			0.157
Language								
English	Reference				Reference			
Other language	1.096	.530	2.266	0.805	1.755	.746	4.126	0.198
Place of birth								
U. S.	Reference				Reference			
Other country	.834	.509	1.365	0.470	1.270	.680	2.373	0.453

HPV awareness								
Yes	Reference				Reference			
No	.067	.037	.123	<0.001	.066	.036	.120	<0.001
Health insurance coverage								
Yes	Reference				Reference			
No	1.157	0.697	1.922	0.573	1.132	.677	1.892	0.637
Region								
Northeast	Reference			<0.001	Reference			<0.001
Midwest	1.288	0.657	2.521	.461	1.236	.629	2.428	.539
South	0.531	0.306	0.921	.024	.532	.305	.928	.026
West	1.465	0.812	2.643	.205	1.446	.799	2.618	.223
Flu vaccine uptake								
Yes	Reference				Reference			
No	0.568	0.384	0.840	0.005	0.560	0.377	0.831	0.004
Pap smear experience								
Yes	Reference				Reference			
No	0.553	0.358	0.856	0.008	0.546	0.352	0.845	0.007
Healthcare delay, transportation								
Yes	2.068	.902	4.739	0.086	2.155	.923	5.030	0.076
No	Reference				Reference			
Medical cost								
Worried	.849	.564	1.276	0.430	.871	.577	1.315	0.511
Not worried	Reference				Reference			
Health Literacy								
Below basic					1.139	.513	2.530	0.749
Above basic					Reference			

Appendix D: Adjusted OR of HPV Vaccine Uptake Stratified by HLL

		Unadjusted ORs				ORs, after adjusting for HL		
		95% CI for Exp (B)				95% CI for Exp (B)		
Variables	Exp B)	Lower	Upper	*p* value	Exp(B)	Lower	Upper	*p* value
Race/Ethnicity								
Hispanics	.766	.571	1.029	.077	.570	.398	.816	.002
Black	Reference				Reference			
HPV awareness								
Yes	Reference				Reference			
No	.072	.041	.126	< .001	.072	.041	.128	< .001
Health insurance coverage								
Yes	Reference				Reference			
No	.620	.417	.923	.018	.701	.466	1.053	.087
Region								
Northeast	Reference			.003	Reference			.005
Midwest	.965	.554	1.681	.900	1.021	.583	1.790	.941
South	.530	.336	.838	.007	.544	.343	.864	.010
West	.882	.550	1.416	.604	.891	.550	1.442	.638
Flu vaccine uptake								
Yes	Reference				Reference			
No	.593	.430	.818	.001	.613	.442	.850	.003
Pap smear experience								
Yes	Reference				Reference			
No	.686	.492	.955	.025	.676	.483	.946	.023
Health care delay, transportation								
Yes	1.510	.757	3.010	.242	1.728	.852	3.506	.129
No	Reference				Reference			
Medical cost								
Worried	.608	.438	.844	.003	.668	.478	.935	.019
Not worried	Reference				Reference			
Perceived health status								
Excellent	Reference			.004	Reference			.003
Very Good	2.025	1.378	2.975	.000	2.024	1.367	2.998	.000
Good	1.745	1.167	2.608	.007	1.773	1.177	2.670	.006
Fair	1.706	1.027	2.832	.039	1.894	1.126	3.187	.016
Poor	3.127	.923	10.596	.067	3.377	.983	11.599	.053