THE DETERMINANTS OF COMPLETING A HUMAN PAPILLOMAVIRUS VACCINATION SERIES IN A SAMPLE OF COLORADO COLLEGE STUDENTS

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Abstract

This paper investigates the determinants of a Colorado College student's being vaccinated for the human papillomavirus (HPV). Data consists of healthcare information, personal information, socioeconomic information, and information regarding one's knowledge of and exposure to HPV and HPV advertisements for ninety-five students. A Logit regression model is used to determine the factors that influence HPV vaccination completion rates. Sexual preference, current standing in school, doctor recommendations, vaccine advertisements, and the religious practices of a student's father are significant determinants.

KEYWORDS: (Human Papillomavirus, HPV, Vaccination, Logit Regression, Preventive Medicine, Gardasil, Cervarix)

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CHAPTER I

INTRODUCTION

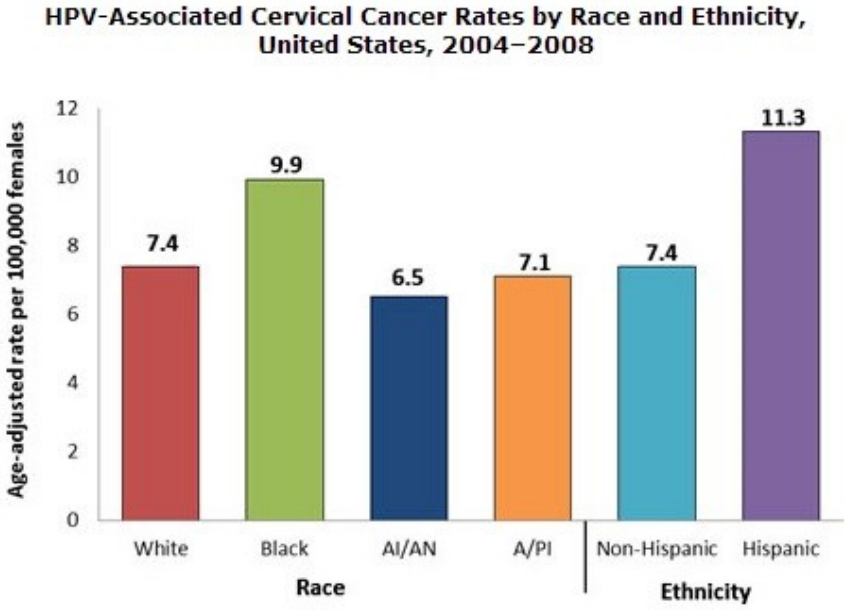
Human Papillomavirus (HPV) is the most common sexually transmitted infection (STI) in the United States. The Center for Disease Control and Prevention (CDC) estimates that about seventy-nine million Americans currently have HPV and that all sexually active men and women will contract HPV at some point in their lives. HPV is usually transmitted during vaginal and anal sex, but can also be transferred during oral sex or genital-to-genital contact between partners. There are more than forty types of HPV, and as such there is no efficient way to test an individual for HPV. Furthermore, individuals with HPV often do not show any symptoms of having the virus and may transmit the infection without knowing he or she is doing so. HPV can be a benign infection as it usually leaves the host's body within one or two years. However, when HPV remains untreated and does not go away it can lead to a variety of cancers as well as genital warts (Human papilloma virus and HPV vaccines FAQ, 2006). In the past decade two vaccines for HPV have been developed and approved. The problem this study addresses is determining the factors that increase vaccination completion rates in a sample of Colorado College students. This paper finds that sexual preference, current standing in school, doctor recommendations, vaccine advertisements, and the religious practices of a student's father are significant determinants.

HPV is the cause of nearly every case of cervical cancer. A woman who contracts HPV may develop cervical cancer within months, years, or even decades if the infection does not leave on its own. It is estimated that ten thousand women in the United States

develop cervical cancer each year, and that four thousand American women die from cervical cancer each year. Figure 1.1 shows the rate of HPV-associated cervical cancer by race and ethnicity in the United States from 2004-2008. HPV can also cause cancer of the anus, vulva, vagina, penis, and oropharyngeal cancer. Aside from cervical cancer, each year there are approximately three thousand new HPV-associated cancers in women in the United States (Wu et al., 2012). In men, there are about seven thousand new cancers caused by HPV in the United States every year, the most common typing being oropharyngeal (Wu et al., 2012). Figure 1.2 displays the rate of HPV-associated oropharyngeal cancer cases in men and women in the United States from 2004-2008. In addition to causing cancers, HPV is responsible for every case of genital warts, a much more widespread health problem. Each year, there are three hundred and sixty thousand new cases of genital warts in the United States. Fortunately, genital warts are not life threatening and either go away on their own or can be removed using various medical procedures. However, while the host has genital warts they cause discomfort in the afflicted areas and are easily transmissible during any sexual encounters (Center for Disease Control and Prevention, 2009).

FIGURE 1.1

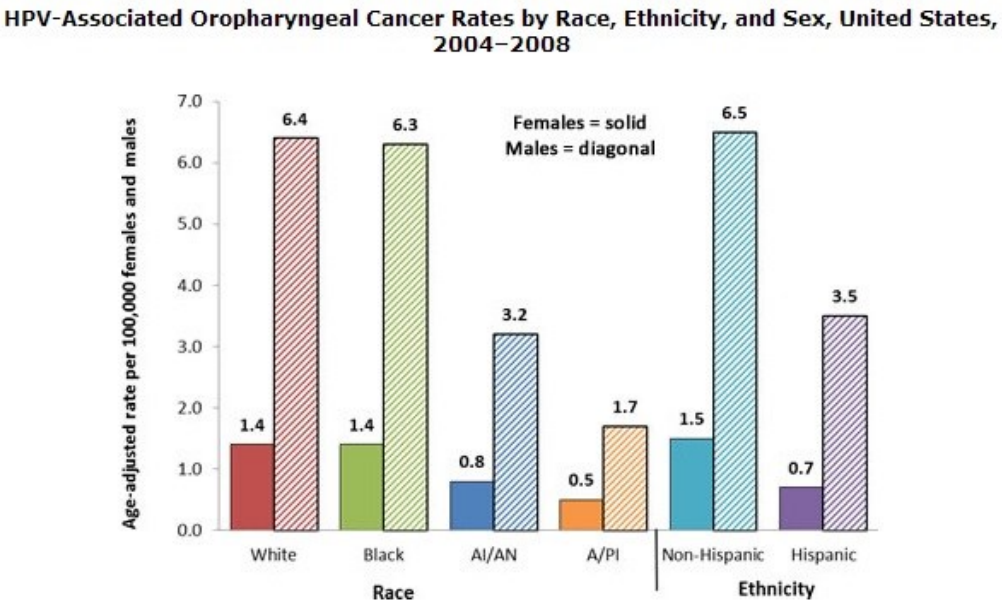
HPV-ASSOCIATED CERVICAL CANCER RATES



Source: Wu et al., 2012

FIGURE 1.2

HPV-ASSOCIATED OROPHARYNGEAL CANCER RATES



Source: Wu et al., 2012

In 2006, the United States Food and Drug Administration (FDA) approved Gardasil®, a vaccine developed by Merck & Co., which prevents HPV strains 6, 11, 16, and 18. HPV types 16 and 18 cause roughly seventy percent of all cervical cancer cases, and are responsible for most cases of HPV-associated cancers of the penis, vulva, vagina, and anus. In addition, HPV strains 6 and 11 cause approximately ninety percent of genital wart cases (Human papilloma virus and HPV vaccines FAQ, 2006). Although Gardasil cannot treat an existing HPV infection, it does prevent one from contracting the other types of HPV that have not already been established in the host. Gardasil is approved for use in both males and females, and the CDC recommends that both genders be vaccinated between the ages of eleven and twelve, or up to age twenty-six if the series was not completed at an earlier age. Gardasil must be administered in three doses over a span of six months in order to be effective (McLemore, 2006). Another vaccine, Cervarix™, was developed by GlaxoSmithKline and approved by the FDA in 2009 for use in females (Monie et al., 2008).

Treating cervical cancer patients is an expensive undertaking. For a woman under the age of sixty-five, the first year of care after being diagnosed for cervical cancer costs approximately $54,000 in 2010 dollars and each additional year of care costs $1,425 in 2010 dollars. Furthermore, if a woman dies as a result of cervical cancer it is estimated that the last year of care costs nearly $118,000 in 2010 dollars (Mariotto et al., 2011). From an economic standpoint it is costlier for a health insurance company to care for a cervical cancer patient compared to vaccinating one adolescent girl or boy. In addition, vaccinating one patient should, in theory, decrease the amount of cervical cancer cases in the future by preventing the transmission of HPV. A problem with these arguments is that

there are approximately ten million boys and girls eligible for HPV vaccination in the United States compared to only twelve thousand cervical cancer patients. Insinga et al. (2005) estimate annual medical costs associated with prevention and treatment of genital warts and HPV-associated cancers of $5 billion. Chesson et al. (2008) find that the average cost per quality-adjusted life year gained by HPV vaccination ranges from $3,906 to $14,723 in 2005 dollars. As HPV vaccinations become more prevalent, more studies must be performed in order to investigate the potential long-run costs of universal HPV vaccination versus the costs of treating cancers associated with HPV.

The next section explores the relevant literature on factors that determine whether a patient initiates an HPV vaccination series. The subsequent chapters describe the dataset and methodology used to regress and test a Logit regression model. Finally, the last sections present the results of the regression model, conclusions drawn, and suggestions for future research.

CHAPTER II

LITERATURE REVIEW

As of 2014, the CDC recommends that all boys and girls aged eleven to twelve be vaccinated for HPV, however, there is not a single state that has made the vaccination mandatory to attend schools (State legislation and statutes, 2011). Therefore, parents must decide whether their children should be vaccinated for HPV. Similarly, legal adults under the age of twenty-six who are not previously vaccinated must decide if they want to complete the vaccination series for HPV. As such, there are many factors that may impact whether a college student has been vaccinated for HPV. Current research suggests that a relationship exists between one's personal characteristics and the likelihood of being vaccinated for HPV (Constantine and Jerman, 2006; Dempsey et al., 2001; Gilkey et al., 2012). Furthermore, doctor recommendations, socioeconomic characteristic, and awareness of HPV and HPV vaccines also influence vaccination acceptance and completion (Guerry et al., 2011; Brewer et al., 2011; Gottlieb et al., 2009).

The following sections review the existing background literature on the factors that impact HPV vaccination completion rates in adolescents. The findings of these studies are necessary in order to understand which variables to include when investigating the factors that influence a Colorado College student being vaccinated for HPV. As such, each of the following sections present characteristics that are used in this paper to find the determinants of completing an HPV vaccination series.

Healthcare Information

Previous research finds that individuals lacking health insurance are less likely to have completed voluntary and mandatory vaccination series. Santoli et al. (2004) estimate that children with private health insurance are eighty percent likely to be up to date in completing recommended vaccinations, whereas children with no health insurance are only sixty-four percent likely to be up to date. Similarly, Jain et al. (2009) find that an individual is more likely to be vaccinated for HPV if he or she is covered by some type of health insurance.

Personal Characteristics

The United States is a very ethnically diverse nation. As its population grows, so does the amount of children who come from different racial and cultural backgrounds. Children eventually become sexually active adults and STI's such as HPV are relevant issues for concern. Therefore, it is important to determine which personal characteristics of children impact the completion rates of HPV vaccinations. Constantine and Jerman (2006) find that Hispanic parents accept HPV vaccination at higher rates, whereas African-American and Asian-American parents are less accepting. Dempsey et al. (2011) and Gilkey et al. (2012) report that Caucasians and African-Americans are less accepting of HPV vaccinations. Another factor that influences HPV vaccination rates is one's gender. Gilkey et al. (2012) report that females are vaccinated for HPV at a higher rate than males.

Although the trend is declining, Petersen and Donnenwerth (1997) find that religious individuals more likely to abstain from premarital sex compared to atheists and

agnostics. Thus, a religious person may not feel threatened by HPV since he or she chooses to abstain from premarital sex and decide not to be vaccinated against HPV.

Heterosexual, homosexual, and bisexual males and females are are all able to contract HPV. Research suggests that a person's sexuality might influence his or her decision to be vaccinated for HPV. Reiter et al. (2010) find that HPV vaccine acceptability is high among homosexual and bisexual men. In addition, Marrazzo et al. (1998) find that HPV infections are more common in homosexual women, which may lead to increased vaccine acceptability.

It has been established that a person's level of sexual activity has a positive relationship with his or her being infected with HPV. Moscicki et al. (1990) find a strong positive relationship between an adolescent's number of sexual partners and HPV infection. Therefore, it makes sense that a person who has more sexual partners will be motivated to be vaccinated for HPV.

Most students in college engage in sexual activity, however, students in different classes do not always behave similarly. Siegel et al. (1999) report that college seniors engage in more frequent sexual activity and use condoms less often when compared to college freshmen. Thus, it seems that older college students take more risks when having sexual intercourse and have a greater incentive to be vaccinated against HPV.

Socioeconomic Characteristics

It is unfortunate that socioeconomic status is a predictor of health. Blaxter (1987) finds that poor and otherwise socioeconomically disadvantaged individuals are typically less healthy than their counterparts. In addition, members of lower socioeconomic classes tend to die earlier in life. These findings can be attributed to lack of insurance, lack of

education, or the inability to pay for healthcare, among other things. In the context of this study, it is worthwhile to determine whether socioeconomic standing impacts initiation and completion rates of HPV vaccinations. Brewer and Fazekas (2007) and Tsui et al. (2012) find that initiation rates are higher among those who have parents with lower education levels. On the other hand, Jain et al. (2008) find that women at higher socioeconomic levels are more likely to complete the vaccination series. It is therefore necessary to determine which socioeconomic variables influence a student's completing an HPV vaccination.

If a father or mother is born outside the United States, he or she is a first generation immigrant and might not have the same access to healthcare as a United States citizen. Lucas et al. (2003) find that foreign-born Black men are less likely to be covered by health insurance. However, Scarinci et al. (2007) find that Latina immigrants would be extremely accepting of a vaccine for HPV. Thus, students with foreign-born parents might be more likely to be vaccinated.

Religious parents have different beliefs on their children engaging in sexual behaviors when compared to agnostic and atheist parents. Petersen and Donnenwerth (1997) find that people who are religious are more inclined to teach their sons and daughters to abstain from premarital sexual activity. In that case, a parent is encouraging abstinence and might not see a reason to have his or her child vaccinated against HPV.

Finally, studies find that divorced parents utilize healthcare differently than parents who are married. Berk and Taylor (1984) report that divorced women use more health services and are more likely to depend on Medicaid coverage when likened to married women. Consequently, one could argue that divorced parents are more accepting

of HPV vaccines because Gardasil and Cervarix are covered by Medicaid for eligible children and because divorced women use healthcare services more frequently than married women.

HPV and HPV Vaccination Awareness

As stated earlier, Gardasil and Cervarix are relatively new vaccines that protect against a well-researched infection: HPV. Although safe-sex education is being taught more frequently in schools throughout the United States, there remains a minority that has little or no knowledge about the disease. It is possible that a person's knowledge of HPV will influence his or her decision to be vaccinated against it. Tsui et al. (2012) find that increased knowledge of HPV is a strong indicator for vaccine initiation. In addition, increased exposure to advertisements for Gardasil or Cervarix will likely have an impact on one's acceptance of said vaccines. Past studies have determined that HPV vaccination awareness impacts acceptance rates for Gardasil and Cervarix. Guerry et al. (2011), Brewer et al. (2011), and Gottlieb et al. (2009) find that completion and initiation rates of HPV vaccines are reduced when patients have never heard of the vaccination or require more information.

Recommendations

Medical Doctors assume an exceedingly important role in society: to keep patients healthy in the short and long-term. One way to ensure long-term health is to vaccinate children against threatening diseases like polio and smallpox. As medical technology advances, more vaccines are developed and used to prevent harmful diseases from manifesting in patients. Gardasil and Cervarix are new vaccines that target common strains of HPV infections in patients. Having only been approved within the last decade,

these vaccines are not mandated by any state, therefore, it is up to medical providers to recommend that children be vaccinated against HPV. Brewer and Fazekas (2007), Gottlieb et al. (2009), Guerry et al. (2011), and Gilkey et al. (2012) find a positive relationship between doctor and provider recommendations and HPV vaccination rates. Additionally, Scarinci et al. (2007) report that recommendations from parents, friends, and other "credible sources" increase acceptability for Gardasil and Cervarix.

CHAPTER III

DATASET

The cross-sectional data in this project contains healthcare information, personal information, socioeconomic information, and information regarding one's knowledge of HPV and HPV vaccinations for ninety-five students who are enrolled at Colorado College during the 2013-2014 academic school year. All study participants are recruited from an online survey created and distributed by email during November, 2013. The questions in the survey can be found in Appendix A. Each participant provides informed consent to answer the questions posed in the survey.

In its original format, the dataset contains twenty-three variables for 112 students. Every international student that completes the survey is dropped from the original dataset because there is no theoretical background to support their inclusion, which leaves fifty-seven women and thirty-eight men, summing to ninety-five total students and twenty-two variables. Of those ninety-five students, sixty-four percent have completed either the Cervarix or Gardasil vaccination series, while seventy-one percent have initiated the series. In addition, sixty-eight percent of the women have completed the vaccination series, compared to only fifty-eight percent of the men. These findings are consistent with a study by Gilkey et al. (2012), who find that adolescent girls are more likely to be vaccinated for HPV compared to adolescent boys.

The dataset includes the following variables: gender, race, sexual orientation, the marital status of one's parents, the religious beliefs of one's parents, one's exposure to information regarding HPV vaccinations, whether or not one has received a

recommendation from a medical doctor or healthcare company, along with many others. The reasons for including these variables are explained in the previous chapter. Table 3.1 displays all of the variables used in this study as well as the summary statistics for each variable.

TABLE 3.1

DESCRIPTIVE STATISTICS FOR ALL VARIABLES MEASURED IN THE SAMPLE

Variable	**Observations**	**Min**	**Max**	**Std. Dev.**	**Mean**
Completed	95	0	1	-	0.642
AlwaysCovered	95	0	1	-	0.926
Gender	95	0	1	-	0.600
Religion	95	1	3	-	-
Race	95	1	5	-	-
Sexuality	95	1	4	-	-
Partners	95	0	30	5.486	5.337
Standing	95	1	4	-	2.684
MotherBorn	95	0	1	-	0.958
FatherBorn	95	0	1	-	0.905
MotherReligion	95	1	3	-	-
FatherReligion	95	1	3	-	-
MotherEducation	95	12	22	1.866	16.137
FatherEducation	95	12	20	1.678	16.189
Marital	95	1	3	-	-
AwarenessVaccine	95	0	15	2.787	3.853
AwarenessHPV	95	5	28	4.974	12.495
FriendRec	95	0	1	-	0.179
ParentRec	95	0	1	-	0.547
TeacherColRec	95	0	1	-	0.295
DoctorRec	95	0	1	-	0.674
ProviderRec	95	0	1	-	0.589

Ten out of twenty-two variables in this project are dummies that take values of zero or one. The mean of a dummy variable is interpreted as the percentage of subjects who gave a positive answer to the survey question. For instance, the mean of ParentRec is 0.547,

which indicates that 54.7% of subjects give a positive response to the question corresponding to ParentRec. Of the remaining twelve variables there are five that take discrete values and seven that are indicator variables. Each variable contains ninety-five observations.

Dependent Variables

The Logit model in this study contains one dependent variable: Completed. Completed is a dummy variable that takes a value of one if a participant completed an HPV vaccination series and a zero otherwise. In essence, the purpose of this project is to determine what independent variables lead to a positive outcome for the variable Completed. Sixty-four percent of participants have completed the vaccination series for HPV (Table 3.1).

Healthcare Variables

Participants who have not completed the vaccination are first asked two questions that will not be used as variables in the Logit regression: their reason for not receiving the vaccination and how likely he or she would be to complete the series in the future. This data is collected so that policy makers can make informed decisions about how to increase vaccination acceptance in the future. For example, Gottlieb et al. (2009) report that twenty-two percent of eligible, non-vaccinated individuals need more information before deciding whether or not they want to be vaccinated. In that case, policy makers might try and find ways to increase the amount of information a person receives about HPV vaccinations in order to increase acceptance. Furthermore, knowing the likelihood of individuals being vaccinated in the future is relevant as this data may validate or contradict trends in vaccine acceptance or refusal.

A dummy variable AlwaysCovered equals one if he or she has always been covered by health insurance and zero otherwise. Table 3.1 indicates that 92.6% of individuals in this study have always been covered by health insurance.

Personal Variables

Gender is a dummy variable that equals one if a participant is a female or zero if a participant is a male. Religion is an indicator variable that equals one for a religious participant, two for an atheist, and three for an agnostic. Race is an indicator variable that equals one for someone who identifies as White, two for someone who identifies as Black, three for someone who identifies as Hispanic or Latino, four for someone who identifies as Asian, and five for someone who identifies as being multiple races. Sexuality is an indicator variable that equals one for a participant that identifies as heterosexual, two for a homosexual, three for a bisexual, and four for a participant whose sexuality is not encompassed by the previous categories. Partners is a variable that equals the number of sexual partners each subject has had in his or her life, including all types of intercourse. Standing is an indicator variable that equals one for a person with freshman standing, two for a sophomore, three for a junior, and four for a senior.

Socioeconomic Variables

MotherBorn and FatherBorn are dummy variables that equal one if the participant's mother or father was born in the United States and zero otherwise, respectively. In this project, ninety-six percent of participants' mothers are born in the United States, whereas only ninety-one percent of the fathers are born in the United States (Table 3.1). MotherReligion and FatherReligion are indicator variables that equal one if his or her mother is religious, two for an atheist parent, or three for an agnostic

parent, respectively. MotherEducation and FatherEducation are variables that denote how many years of school each parent completed, respectively. The participant enters twelve if a parent finished high school, sixteen if a parent completed a Bachelor's Degree, etc. On average, mothers and fathers of subjects in this study have completed sixteen years of education, as shown in Table 3.1. Marital is an indicator variable that equals one if a subject's parents are married, two if his or her parents are divorced, and three if the contributor's parents are unmarried but in some kind of monogamous relationship.

HPV Knowledge and HPV Vaccination Awareness Variables

AwarenessVaccine is a variable that measures how many times an individual has seen advertisements for Gardasil or Cervarix in one's life from any media source. Students in this study have been exposed to four advertisements for HPV vaccines, on average (see Table 3.1). AwarenessHPV is a variable that is equal to how many times a participant has been educated or seen information about HPV in his or her lifetime, not including information regarding HPV vaccines. Table 3.1 displays that participants have been educated about HPV twelve times, on average. FriendRec, ParentRec, TeacherColRec, DoctorRec, and ProviderRec are dummy variables that equal one if a friend, parent or guardian, teacher or colleague, doctor, or health insurance provider has ever recommended that a participant be vaccinated for HPV and zero otherwise, respectively. Eighteen, fifty-five, thirty, sixty-seven, and fifty-nine percent of subjects in this study have received recommendations from friends, parents, teachers or colleagues, doctors, or health providers, respectively (Table 3.1).

Predicted Signs

Table 3.2 displays the predicted signs for each of the variables in the model.

TABLE 3.2

PREDICTED SIGNS FOR VARIABLE COEFFICIENTS

Variable	Predicted Sign	Variable	Predicted Sign
AlwaysCovered	+	MotherBorn	-
Gender	+	FatherBorn	-
Religion		MotherReligion	
Atheist	+	Atheist	+
Agnostic	+	Agnostic	+
Race		FatherReligion	
Black	-	Atheist	+
Hispanic or Latino	+	Agnostic	+
Asian	-	MotherEducation	-
Mixed Races	+/-	FatherEducation	-
Sexuality		Marital	
Homosexual	+	Divorced	+
Bisexual	+	Unmarried Relationship	+/-
"Other"	+/-	AwarenessVaccine	+
Partners	+	AwarenessHPV	+
Standing		FriendRec	+
Sophomore	+	ParentRec	+
Junior	+	TeacherColRec	+
Senior	+	DoctorRec	+
		ProviderRec	+

It is important to realize that Table 3.2 includes discrete, dummy, and indicator variables. Interpretations of Table 3.2 should be made as in the following examples: FriendRec is a dummy variable that will theoretically increase vaccination rates if its value is equal to one; FatherReligion is an indicator variable and a father's being atheist or agnostic should theoretically increase the vaccination rate when likened to a religious father; Partners is a

discrete variable that should theoretically have a positive relationship with the chances of one's being vaccinated.

AlwaysCovered and every type of recommendation should theoretically increase the likelihood of one's being vaccinated for HPV (Santoli et al., 2004; Jain et al., 2009; Brewer and Fazekas, 2007; Gottlieb et al., 2009; Guerry et al., 2011; Gilkey et al., 2012; Scarinci et al., 2007). Being female, atheist, or agnostic should also increase the chances of being vaccinated (Gilkey et al., 2012; Petersen and Donnenwerth, 1997). Homosexuals, bisexuals, sophomores, juniors, and seniors should theoretically have completed HPV vaccinations more often (Reiter et al., 2010; Marrazzo et al., 1998; Siegel et al., 1999). Students with more sexual partners or mothers and fathers who are atheist or agnostic are theorized to be vaccinated for HPV more often (Petersen and Donnenwerth, 1997; Moscicki et al., 1990). Increased exposure to information about HPV or advertisements for HPV vaccines should increase the likelihood of one's being vaccinated (Tsui et al., 2012; Guerry et al., 2011; Brewer et al., 2011; Gottlieb et al., 2009). According to the literature, Hispanic or Latino students are vaccinated for HPV more often (Constantine and Jerman, 2006). Students with divorced parents are theorized to be vaccinated for HPV at a higher rate (Berk and Taylor, 1984).

On the other hand, Asian and African-American subjects are theorized to be vaccinated less frequently (Constantine and Jerman, 2006; Dempsey et al., 2011; Gilkey et al., 2012). Finally, a student with a mother or father that is less educated or born within the United States should have a lesser chance of being vaccinated (Brewer and Fazekas, 2007; Tsui et al., 2012; Scarinci et al., 2007).

CHAPTER IV

METHODOLOGY

In order to measure the determinants of HPV vaccination in students attending Colorado College, the data is regressed using a Logit regression model. A Logit regression is being used because the dependent variable is dichotomous: an individual has either completed an HPV vaccination series, or not. Furthermore, a Logit regression can make use of multiple independent variables that may be continuous, discrete, dummy, or indicator variables. In order to account for the fact that a Logit regression predicts binary outcomes, it is necessary that the regression takes the natural logarithm of the probability that the dependent variable is obtained. This transforms the dependent variable into continuous values, which allows one to calculate coefficients and marginal effects for each independent variable.

The coefficients for the independent variables in this study are calculated using a Logit model, which implies maximum likelihood estimations. In essence, the maximum likelihood estimation seeks to maximize the agreement of the model with the observed data (Hosmer et al., 2013).

In order to run a Logit regression with the cross-sectional data used in this project, dummy variables, indicator variables, and discrete variables are utilized. Stata 13 is used to estimate the following Logit regression equation, which measures the probability that a Colorado College student completed an HPV vaccination series given various characteristics of the individual.

$$Completed = \beta_0 + \beta_1 AlwaysCovered + \beta_2 Gender + B_3 RELIGION + B_4 RACE + B_5 SEXUALITY + \beta_6 Partners + B_7 STANDING + \beta_8 MotherBorn + \beta_9 FatherBorn + B_{10} MOTHERRELIGION + B_{11} FATHERRELIGION + \beta_{12} MotherEducation + \beta_{13} FatherEducation + B_{14} MARITAL + \beta_{15} AwarenessVaccine + \beta_{16} AwarenessHPV + \beta_{17} FriendRec + \beta_{18} ParentRec + \beta_{19} TeacherColRec + \beta_{20} DoctorRec + \beta_{21} ProviderRec + \varepsilon \quad (4.1)$$

Each variable in Equation 4.1 has a corresponding coefficient or matrix of coefficients that will be calculated. The term β_0 is the constant term for the Logit model. Each indicator variable used in the model is printed in all capital letters in equation 4.1 and has a matrix of coefficients, denoted B_i, rather than a single coefficient β_i. Being atheist, for example, has its own coefficient when compared to being agnostic.

CHAPTER V

RESULTS

Regression Analysis

To analyze the determinants of Colorado College students' completing an HPV vaccination series, a Logit regression is run and tested. The regression is tested for heteroskedasticity, multicollinearity, and normality of the error terms. After running the three tests, it was apparent that heteroskedasticity and normality or the error terms were issues, whereas multicollinearity is not a problem. To correct for heteroskedasticity and normality of the error terms, a robust Logit regression is used.

After running a robust Logit regression, the coefficients for each independent variable are determined. The results of this regression are shown in table 5.1. Since the model includes dummy and indicator variables, it should be noted that coefficients for these variables are to be interpreted as a change compared to a dummy variable equaling zero or an indicator variable equaling one. Subsequently, the marginal effects for each variable are determined. The marginal effects are also displayed in table 5.1. Once again, it is important to remember that the regression includes dummy and indicator variables. When analyzing the impact of one's religious beliefs on HPV vaccination, for instance, interpret the marginal effects as a percent change from an atheist person versus one who is religious. Similarly, interpret the marginal effect for a female as a percent change in the likelihood of being vaccinated compared to a male. The following table displays the coefficients and marginal effects for each variable in the Logit regression.

TABLE 5.1

COEFFICIENTS AND MARGINAL EFFECTS FOR EACH VARIABLE

95 Observations, Dependent Variable: Completed		
Method / Variable	Coefficient	Marginal Effect
AlwaysCovered	1.641	0.247
	(1.587)	(0.227)
Gender	0.687	0.103
	(0.536)	(0.078)
Religion		
Atheist	1.288	0.182
	(0.983)	(0.129)
Agnostic	0.173	0.026
	(0.824)	(0.123)
Race		
Black	-0.347	-0.051
	(1.052)	(0.155)
Hispanic or Latino	-1.204	-0.177
	(1.312)	(0.184)
Asian	-0.250	-0.037
	(1.437)	(0.215)
Mixed Races	-0.199	-0.029
	(0.813)	(0.120)
Sexuality		
Homosexual	-0.269	-0.039
	(1.659)	(0.241)
Bisexual	-2.322*	-0.322*
	(1.310)	(0.145)
"Other"	-0.279	-0.040
	(1.363)	(0.199)
Partners	-0.019	-0.003
	(0.053)	(0.008)
Standing		
Sophomore	-3.608	-0.278*
	(2.433)	(0.114)
Junior	-5.747*	-0.623*
	(2.347)	(0.076)
Senior	-4.001*	-0.337*
	(2.379)	(0.099)

TABLE 5.1 CONTINUED

95 Observations, Dependent Variable: Completed		
Variable \ Method	Coefficient	Marginal Effect
MotherBorn	-1.487	-0.224
	(1.788)	(0.268)
FatherBorn	0.195	0.029
	(1.224)	(0.183)
MotherReligion		
Atheist	-1.045	-0.155
	(1.046)	(0.147)
Agnostic	-0.211	-0.031
	(1.130)	(0.164)
FatherReligion		
Atheist	0.716	0.100
	(1.066)	(0.148)
Agnostic	-1.814*	-0.264*
	(0.807)	(0.106)
MotherEducation	0.233	0.035
	(0.189)	(0.027)
FatherEducation	0.044	0.007
	(0.197)	(0.029)
Marital		
Divorced	0.401	0.060
	(0.616)	(0.089)
Unmarried Relationship	-1.397	-0.206
	(1.979)	(0.251)
AwarenessVaccine	0.361*	0.054*
	(0.142)	(0.019)
AwarenessHPV	-0.087	-0.013
	(0.070)	(0.010)

TABLE 5.1 CONTINUED

95 Observations, Dependent Variable: Completed		
Method / Variable	Coefficient	Marginal Effect
FriendRec	0.097	0.015
	(0.853)	(0.129)
ParentRec	0.248	0.037
	(0.706)	(0.109)
TeacherColRec	0.781	0.118
	(0.839)	(0.131)
DoctorRec	-1.467*	-0.221*
	(0.775)	(0.106)
ProviderRec	-0.447	-0.067
	(0.585)	(0.088)
Pseudo R^2	0.309	-
Wald Chi^2	34.9	-

*Indicates significance at the 10% level.
Note: Each column provides either the coefficient or marginal effect and the robust standard error for each variable.

Personal Characteristics

This study investigates various personal characteristics that may impact an individual's being vaccinated for HPV and finds that gender[1], religious beliefs[2], ethnicity[3], and number of sexual partners[4] are not significant determinants of HPV vaccination.

Reiter et al. (2010) report that vaccine acceptability is higher among gay and bisexual men when compared to heterosexual men. This study, on the other hand, determines that bisexual individuals are thirty-two percent less likely to have completed

[1] P value of 0.187
[2] P values of 0.156 and 0.835 for atheists and agnostics compared to those who practice a religion, respectively
[3] P values of 0.741, 0.335, 0.864, and 0.808, respectively for different ethnic groups.
[4] P value of 0.723

the vaccinations compared to heterosexuals, on average (Table 5.1). This discrepancy can be attributed to the fact that only six bisexuals are in the dataset, compared to eighty heterosexuals. Furthermore, this study uses a large amount of parameters for a very small dataset, which may have impacted these findings. It should also be noted that data for homosexual and "other" sexualities are not significant determining factors[5]. This lack of significance is perhaps due to the fact that this study only contains ninety-five observations, and very few participants are homosexual or have "other" sexual preferences.

The last personal characteristic is the impact of one's current standing at Colorado College on HPV vaccination completion. Siegel et al. (1999) find that older college students engage in more frequent and riskier sexual activity, which may increase the incentive for older students to be vaccinated for HPV. This project reports that being a sophomore, junior, or senior reduces the chances of one being vaccinated for HPV at the five percent level of significance. On average, sophomores at Colorado College are twenty-eight percent less likely to have been vaccinated compared to freshmen, whereas juniors and seniors are sixty-two and thirty-four percent less likely to have been vaccinated compared to freshmen, respectively (Table 5.1). Although these findings are significant, they contradict the preexisting literature. Once again, using a small sample size and numerous parameters might have impacted the marginal effects to a high degree as it seems unlikely that being a junior at Colorado College would reduce the likelihood of being vaccinated by sixty-two percent when compared to a freshman. An alternative explanation is that riskier and more frequent sexual activity might be a sign of carelessness and ignorance. If that is the case, seniors at Colorado College are more

[5] P values of 0.872 and 0.839 for homosexuals and "other" sexualities, respectively

careless than freshmen when having sex, which explains why older students are vaccinated less often.

Socioeconomic Characteristics

This study finds that most of the included socioeconomic characteristic variables have no significance in determining the likelihood of vaccination completion. The birthplace[6], level of education[7], and marital status[8] of one's mother and father are insignificant, as well as the religious beliefs[9] of a student's mother. This study determines that the only significant parental factor for a son or daughter's completing a HPV vaccination series is whether the father is agnostic. In a previous project, Petersen and Donnenwerth (1997) find that religious parents are more likely to teach their sons and daughters to practice abstinence. This study then conjectures that teaching abstinence might also coincide with a reduced rate of HPV vaccination in adolescents. However, this project determines that Colorado College students with agnostic fathers are twenty-six percent less likely to have been vaccinated for HPV compared to a test subject who has a religious father, on average (Table 5.1). There are two forthcoming explanations for this discrepancy: religious fathers of Colorado College students do not have traditional religious opinions on premarital sex, and the results of the Logit regression are influenced by the small dataset and high number of parameters.

Exposure to Information about HPV and HPV Vaccinations

One of the aims of this study is to build on the existing literature by determining whether information about HPV and HPV vaccinations increases the probability that one

[6] P values of 0.402 and 0.873 for mothers and fathers born outside the United States, respectively
[7] P values of 0.188 and 0.823 for the education level of mothers and fathers, respectively
[8] P values of 0.498 and 0.411 for divorced and parents who are unmarried but in a relationship when compared to married parents, respectively
[9] P values of 0.291 and 0.852 for atheist and agnostic mothers compared to religious mothers, respectively

completes an HPV vaccination series. Scarinci et al. (2007), Guerry et al. (2011), and Gottlieb et al. (2009) find that vaccination completion rates are higher when a person has seen advertisements for Gardasil or Cervarix more than once. On average, a Colorado College student is five percent more likely to have been vaccinated for HPV for each additional Gardasil or Cervarix advertisement he or she is exposed to (Table 5.1). Increased exposure to information about HPV has no significance[10].

Finally, subjects responded to questions regarding whether healthcare companies, doctors, friends, teachers or colleagues, or parents have recommended completing an HPV vaccination series. Brewer and Fazekas (2007), Gottlieb et al. (2009), Guerry et al. (2011), and Gilkey et al. (2012) report that doctor recommendations increase vaccination completion rates. This project finds evidence to the contrary: students who receive a recommendation from a doctor are twenty-two percent less likely to be vaccinated, on average (Table 5.1). The relatively small dataset and large number of predictor variables might be responsible for this incongruity. Recommendations from friends, parents, teachers or colleagues, and health insurance companies are not significant[11].

Non-Vaccinated Students

Subjects who are not vaccinated before this study are asked how likely it is that they will be vaccinated in the future using a scale from one to ten and their reason for not being vaccinated. On average, subjects are likely to be vaccinated in the future[12]. The most common answer for not having been vaccinated is that the subject or his or her parents were skeptical of the vaccination's long-term effectiveness.

[10] P value of 0.190
[11] P values of 0.909, 0.732, 0.367, 0.444 for friends, parents, teachers or colleagues, and health insurance companies, respectively
[12] Score of 5.5 out of 10

Summary

This study finds several factors that impact HPV vaccination completion rates in Colorado College students. Bisexual students are thirty-two percent less likely to have completed an HPV vaccination when compared to a heterosexual, on average (Table 5.1). In addition, this project finds that one's standing at Colorado College is a determinant for his or her completing a vaccination series. Sophomores, juniors, and seniors are all vaccinated for HPV at a lesser rate when compared to freshmen (Table 5.1). The only socioeconomic variable that is significant is whether or not a father of a student is agnostic. This study finds that students with agnostic fathers are twenty-six percent less likely to have been vaccinated compared to those with religious fathers (Table 5.1). In addition, the impact of exposure to HPV vaccine advertisements is assessed. This project reports that the likelihood of a Colorado College student's being vaccinated increases by five percent for each additional Gardasil or Cervarix advertisement he or she is exposed to (Table 5.1). Finally, recommendations from doctors are shown to decrease the chances of a Colorado College student being vaccinated for HPV. It should be noted that every result contradicts the existing literature except for vaccine advertisements increasing the likelihood of one's being vaccinated. These discrepancies are perhaps results of using many parameters in conjunction with a small dataset.

CHAPTER VI

CONCLUSIONS AND FURTHER RESEARCH

The main objective of this study is to determine the factors that impact the chances of a Colorado College student being vaccinated for HPV. Since HPV is the most common STI, it is important to understand how healthcare costs can be reduced in the long-run by mitigating genital warts and HPV-associated cancers. Furthermore, decreasing the prevalence of these ailments will increase the overall quality of life for individuals that are sexually active at any point during their lives. A way to address both of these ideas is to increase HPV vaccination completion rates in eligible patients through policy making, doctor recommendations, or other strategies.

While previous studies have focused on the impact of vaccine advertisements, ethnicity, and doctor recommendations, hardly any research has been performed to determine the effects of religion, sexuality, and socioeconomic factors on vaccine completion rates. It might take decades before HPV vaccinations are mandated in schools, and thus it is important to increase completion rates in patients as soon as possible. The first step in increasing HPV vaccinations is to understand which patients are less likely to be vaccinated to begin with, and to determine the factors that impact vaccination rates either positively or negatively. This study reports that bisexuals, non-freshmen college students, patients with agnostic fathers, and individuals who received a recommendation from a doctor are less likely to have been vaccinated against HPV. On the other hand, the probability of a Colorado College student's being vaccinated increases for each additional Gardasil or Cervarix advertisement he or she is exposed to.

Future research should be performed to confirm or deny the findings of this study as many of the results contradict the current literature. Additionally, variables that are insignificant in this paper should be investigated. Finally, more studies should be conducted to determine whether the costs of treating HPV-associated cancers and genital warts outweigh the costs of universal HPV vaccination, especially when considering the fact that the long-term effectiveness of Gardasil and Cervarix is yet to be determined.

APPENDIX A

QUESTIONNAIRE

Healthcare Characteristics

1. Have you completed the vaccination series for Gardasil or Cervarix?
2. For those who haven't been vaccinated, why not? (Possible answers: I/my parents didn't know vaccinations for HPV existed, I/my parents didn't have enough information about the vaccinations, I/my parents didn't want me to get the vaccinations, I/my parents were skeptical of the vaccination's long-term effectiveness, the co-pay for the vaccination was too expensive, other: please explain)
3. For those who haven't been vaccinated, on a scale of one to ten (ten being absolutely certain), how likely is it that you'll be vaccinated for HPV in the future?
4. Have you always been covered by some type of health insurance?

Personal Characteristics

5. Do you identify as a male, female, or other?
6. Are you religious, atheist, agnostic, or other?
7. Are you an international student?
8. For those who aren't international students, do you identify as White, Black, Hispanic or Latino, Asian, or multiple races?
9. Would you consider yourself to be heterosexual, homosexual, bisexual, or other?
10. How many sexual partners have you had in your lifetime? (Including any kind of sexual intercourse)

11. What is your current class standing (freshmen, sophomore, etc.)?

Socioeconomic Characteristics

12. Was your mother born in the United States?
13. Was your father born in the United States?
14. Is your biological mother religious, atheist, agnostic, or other?
15. Is your biological father religious, atheist, agnostic, or other?
16. How many years of education did your biological mother complete? (Finishing high school counts as twelve, finishing a Bachelor's degree counts as sixteen, etc.)
17. How many years of education did your biological father complete? (Finishing high school counts as twelve, finishing a Bachelor's degree counts as sixteen, etc.)
18. Are your biological parents married, divorced, unmarried but in some kind of monogamous relationship, or other?

Exposure to Information About HPV and HPV Vaccinations

19. Approximately how many advertisements (any kind of media) have you seen for Gardasil or Cervarix in your lifetime?
20. Approximately how many times have you been educated or seen advertisements with information about HPV in your lifetime (not including information about Gardasil or Cervarix)?
21. Has a friend ever recommended you get a vaccination series to prevent certain types of HPV?

22. Has a parent and/or guardian ever recommended you get a vaccination series to prevent certain types of HPV?
23. Has a teacher or colleague ever recommended you get a vaccination series to prevent certain types of HPV?
24. Has a Medical Doctor ever recommended you get a vaccination series to prevent certain types of HPV?
25. Has a health insurance company ever recommended you get a vaccination series to prevent certain types of HPV?

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