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# Health literacy and its association with human papilloma virus vaccination among adults: Findings from the behavioral risk factor surveillance system

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## ABSTRACT

Health literacy is associated with the utilization of preventive health services. We examined the association between health literacy (HL) levels and receipt of at least one dose of the human papilloma virus (HPV) vaccination. We analyzed the data from the 2016 Behavioral Risk Factor Surveillance System (BRFSS) among adults aged 18 to 32. The primary outcome variable was the 'yes/no' response to the question that assessed whether the participant received at least the first dose of HPV vaccination. The primary independent variable was a summative HL score (range 3 through 12) we created for each respondent by adding the scores for all three HL questions. We performed bivariate and multivariable (logistic regression) analyses to examine the relationship between study variables. The analytical sample of 6,731 adults aged 18 to 32 met the eligibility criteria. Regression analyses showed that the odds of having received at least one dose of HPV vaccination increased by 13% for every unit increase in health literacy score (Odds ratio: 1.13, 95% CI: 1.06–1.21,  $p < .0001$ ). Age, gender, marital status, race/ethnicity, insurance status, and having regular access to a personal doctor were predictors of HPV vaccination status. This study showed that higher levels of HL may contribute to the uptake of at least one dose of the HPV vaccine. Health care and public health organizations, health care professionals, and policymakers should emphasize improving the health literacy levels of the patients and the public to increase the uptake of the HPV vaccine.

## ARTICLE HISTORY

Received 3 August 2022  
Revised 26 September 2022  
Accepted 9 October 2022

## KEYWORDS

Health literacy; human papilloma virus; human papilloma virus vaccine; BRFSS



## Introduction

According to the Centers for Disease Control and Prevention (CDC), human papillomavirus (HPV) infection is the most prevalent sexually transmitted infection (STI) in the United States.<sup>1</sup> The total number of people aged 15 to 59 infected with one or more disease-associated HPV types for 2018 was estimated at 42.5 million, with an estimated 13 million newly infected that year.<sup>2</sup> HPV infections lead to diseases like anogenital warts, recurrent respiratory papillomatosis, cervical intraepithelial neoplasia, oropharyngeal cancers, and many anogenital cancers in men and women, including penile, anal, vaginal, vulvar, and cervical cancers.<sup>3</sup> These diseases impose a substantial public health burden, and the treatments rendered to cure these diseases impose a significant economic burden.<sup>4</sup> For example, among those aged 15 to 59 years infected with HPV, the discounted lifetime medical costs of illnesses attributed to HPV infections were estimated at \$774 million in 2018.<sup>4</sup>

Vaccines are one of the most significant public health and biomedical science achievements.<sup>5</sup> Vaccines have increased life expectancy across the globe.<sup>6</sup> They have promoted economic growth because they decrease morbidity and mortality by preventing diseases.<sup>6</sup> HPV is an STI that can be easily prevented through age-appropriate HPV vaccinations.<sup>7</sup> For the first time, quadrivalent HPV vaccine types 6,11,16,18 (HPV4, GARDASIL™) were licensed by the U.S. Food and Drug Administration (FDA) in June 2006 for use in females aged 9

to 26 years.<sup>7</sup> The FDA approved a bivalent HPV vaccine (HPV2, Cervarix) in October 2009 for females aged 10 to 25 years.<sup>8</sup> In October 2009, the FDA approved the HPV4 vaccine for males aged 9 to 26. These vaccines were approved to prevent anogenital cancers and warts. The CDC's Advisory Committee on Immunization Practice (ACIP) recommends routine vaccination of two doses at 11 or 12 years, with vaccinations starting as early as nine years.<sup>9</sup> ACIP also recommends catch-up vaccination for all persons through age 26 if they are not adequately vaccinated.<sup>9</sup> In 2020, the FDA approved the Gardasil™ HPV vaccine to prevent oropharyngeal cancers (OPCs).<sup>10</sup>

Though clear guidelines for HPV vaccinations have existed for over a decade, data shows that the prevalence of HPV vaccinations in children and young adults in the U.S. is still low. A study utilizing the National Health Interview Survey data from 2010 through 2018 found that only 42% of females and 16% of males of ages 18 to 21 years reported receiving one dose of HPV vaccine at any age.<sup>11</sup> In a similar national study, using data from the 2013–2019 National Health Interview Survey, it was found that only 40% of adults aged 18 to 26 had at least one HPV vaccination dose.<sup>12</sup> Multiple studies have described children and adults who have received HPV vaccination compared to those who did not. Low HPV vaccination rates among different subgroups of the population have been

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associated with racial/ethnic minorities,<sup>13</sup> college or less than college maternal education,<sup>14</sup> not having a well-child doctor visit,<sup>14</sup> not seeing a health care provider in the past 12 months,<sup>15</sup> not having health insurance,<sup>15</sup> living in a lower-income household,<sup>15</sup> not receiving a provider recommendation for HPV vaccine,<sup>14,16</sup> and lack of enough knowledge about the vaccine.<sup>16</sup>

The Institute of Medicine defined health literacy (HL) as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions.”<sup>17</sup> In the last two decades, many studies have established the association between low HL, poor health outcomes, and poorer use of health care services. These studies show that low HL is associated with more use of emergency care, lower adherence to regular medication intake, inadequate ability to interpret or understand health messages and labels, more hospitalizations that could have been prevented, and lower use of preventive services.<sup>18</sup> Lower HL has also been associated with lower utilization of vaccines.<sup>18–20</sup> A nationwide study of MarketScan Commercial insurance claims data of 18- to 64-year-old patients determined that those living in areas with higher health literacy were more likely to have received pneumococcal vaccines.<sup>19</sup> In a similar study of adults aged 50 and above, those with higher health literacy received timely herpes zoster vaccination.<sup>20</sup>

A few studies have explored HL in context to HPV and HPV vaccinations. In a cross-sectional study of young adults, those with higher HPV literacy levels were more likely to be associated with HPV vaccination initiation and completion than those with lower health literacy levels.<sup>21</sup> Though HL levels were not different between undergraduate students who did and did not receive HPV vaccination, a higher HL score was associated with higher knowledge about HPV and available vaccines.<sup>22</sup> Among undergraduate students aged 18 to 26 who responded to a survey, those with higher HPV and HPV vaccine awareness also had higher levels of HL.<sup>23</sup> Though the above studies demonstrate HL and its association with HPV awareness, vaccine awareness, and vaccination status, they were all small-scale studies, focusing on undergraduate students, and were based on convenience samples. Therefore, our study assessed the association between HL and the receipt of at least one HPV vaccination dose among non-institutionalized adults aged 18 to 32 years using the 2016 Behavioral Risk Factor Surveillance System (BRFSS) data. We hypothesize that odds of having received at least one dose of HPV vaccination will increase with higher HL levels.

## Methods

### Data source

In this study, we used the 2016 BRFSS data. BRFSS is a system of ongoing health-related landline and cellular telephone surveys administered annually by the CDC in all the states within the United States and participating US territories. Participants are recruited through random digit dialing and the survey uses a disproportionate stratified sample design for landline telephone samples and a random sample design for the cellular

telephone survey. Non-institutionalized resident adults of ages 18 years and above are the primary target population for this survey.<sup>24</sup> The main goal of this survey is to collect data on adults' health behaviors, health conditions, diseases, access to care, and utilization of health care services.<sup>24</sup> The survey comprises three-part questions: questions administered across all states (core component), questions based on specific topics (optional component), and questions administered only by individual states. More details on the 2016 BRFSS methodology are available from the CDC.<sup>24</sup>

### Main independent variable

In 2016, BRFSS, for the very first time, administered the optional HL module comprising of 3 HL-related questions in 17 states and territories, which included:<sup>25</sup> Alabama, Alaska, District of Columbia, Georgia, Illinois, Iowa, Louisiana, Kansas, Maryland, Minnesota, Mississippi, Nebraska, North Carolina, Oklahoma, Pennsylvania, Puerto Rico, and Virginia.

The three HL-related questions were: 1) “How difficult is it for you to get advice or information about health or medical topics if you need it?,” 2) “How difficult is it for you to understand information that doctors, nurses, and other health professionals tell you?” and 3) “In general, how difficult it is for you to understand written information?”<sup>26</sup> The possible responses were ‘very difficult,’ ‘somewhat difficult,’ ‘somewhat easy,’ ‘very easy,’ ‘I don’t look for health information,’ and ‘don’t know/not sure’. For statistical purposes, we coded the responses from 1 to 4, with ‘very difficult’ coded as 1 and ‘very easy’ as 4. We excluded ‘I don’t look for health information,’ and ‘don’t know/not sure’ categories from data analysis. We created a summative HL score (range 3 through 12) for each respondent by adding the scores for all the three HL questions, with a higher score indicating higher health literacy levels.

### Main outcome variable

HPV vaccination status was assessed in adults of ages 18 to 49 years by asking them, “A vaccine to prevent the human papillomavirus, or HPV infection is available and is called cervical cancer or genital warts vaccine or HPV shot. Have you ever had an HPV vaccination?” The interviewer also mentioned the brand name of the HPV vaccine as “Gardasil or Cervarix” if the respondent was a female and “Gardasil” if it was a male.<sup>26</sup> The possible responses were “Yes,” “No,” “Doctor refused when asked,” or “Don’t know/Not sure.” We included only those who responded by answering “Yes” or “No” to this question in our analysis. This question assessed if the participants received at least one dose of HPV vaccination or not.

### Demographic and other variables

The analytical sample was described based on the following demographic variables and their categories: age, gender, marital status, race/ethnicity, educational status, and household income. We restricted our analytical sample to adults of ages 18 to 32 years. In 2009, FDA approved the bivalent vaccine for both males and females, though it had approved the quadrivalent vaccine for females in 2006. Therefore, taking the year

2009 as the reference point, we assumed that if someone were aged 25 or 26 in 2009, they probably would be 32 or 33 in 2016 (when the 2016 BRFSS was conducted). Choosing a conservative estimate of 32, we restricted the analytical sample to 18 to 32-year-old adults. We categorized the sample into two age categories (18 to 25, 26 to 32). Marital status was assessed in BRFSS through 6 different categories. We categorized those who were married or with partners into one group and the others (separated/widowed/divorced/never married) into another. Self-identified race/ethnicity was categorized into non-Hispanic White, non-Hispanic Black, non-Hispanic other, multiracial Hispanic, and Hispanics. Those with different educational levels were categorized into four groups: those with less than 12<sup>th</sup>-grade level education, grade 12<sup>th</sup> or Graduate Education Diploma (GED), some college or technical school, and a college graduate. The analytical sample was categorized based on income into those with an annual household income level of \$20,000 or less, \$21,000 to \$50,000, and those with more than \$50,000. Participants were asked if they had any kind of health care coverage that included health insurance, prepaid plans such as Health Maintenance Organizations (HMOs), government plans such as Medicare, or Indian Health Services. Participants were categorized into having and not having any health insurance coverage if they answered “Yes” or “No” to this question, respectively. Participants were asked, “Do you have one person you think of as your personal doctor or health care provider?” to assess participants’ regular access to the primary care provider. If participants answered either “only one or more than one,” they were considered to have regular access to a health care provider. In contrast, those who answered “No” were supposed not to have regular access to a health care provider. All missing values among the variables mentioned above were excluded from the analysis.

### Data analysis

A total analytical sample of 6,731 adults aged 18 to 32 years met the eligibility criteria. All categorical and numeric variables were described using appropriate descriptive statistics. For example, all categorical variables were expressed as frequencies and percentages, whereas all continuous numeric variables as mean and standard deviation. All categorical variables were cross-tabulated by the outcome variable (respondents with and without HPV vaccination). Wherever appropriate, a Chi-Square and Fisher test were used to compare the proportion of the outcome variable across the categories of each categorical variable. An Independent student t-test was used to test the mean difference in HL score between those vaccinated versus those who were not. Furthermore, multivariable logistic regression was used to determine the odds ratio for the binary outcome variable (HPV vaccination – Yes/No) using all categorical and numeric variables as predictors. We used the composite HL variable as the primary independent variable. This study is exempt from review by an Institution Review Board as the BRFSS dataset is publicly available and has no identifiable information. A p-value of 0.05 was used for all statistical tests, and all statistical analysis was done using SAS version 9.4, SAS Institute, Cary, NC.

## Results

Most of our sample ( $n = 6,731$ ) were of ages 18 to 25 years (53.6%), females (51.6%), separated/widowed/divorced/never married (67.5%), and non-Hispanic whites (60.0%) (Table 1). The majority of the participants (26.9%) reported having some college-related education and above, with approximately 63.2% reporting to have a household income of \$50,000 and less. Most respondents perceived that it was very easy or somewhat easy to get advice or information about health topics when needed (95.9%). Similarly, 94.2% and 93.8% reported that it was very easy or somewhat easy to understand the information health care providers offer and written health information. Almost 82.5% had health care coverage, with approximately 62.8% reporting that they had a personal doctor or a health care provider when needed. Only 26.2% reported ever having had an HPV vaccination. (Table 1).

Table 2 describes the analytical sample by categorizing them into those who ever had an HPV vaccination compared to those who never had. There were significant differences in vaccination rates by age ( $p < .0001$ ), gender ( $p < .0001$ ), marital status ( $p < .0001$ ), race/ethnicity ( $p < .024$ ), educational status ( $p < .0001$ ), household income level ( $p = .021$ ), health care coverage ( $p < .0001$ ), and having access to a personal doctor or health care provider when needed ( $p = .005$ ). The vaccination rate was the lowest among 26 to 32-year-olds (17.7%) within the subgroups. Significant differences in vaccination rates were observed based on the three individual health literacy variables: ability to get advice about health topics ( $p = .004$ ), understanding information provided by health care providers ( $p < .0001$ ), and understanding written health information ( $p = .0002$ ). The mean HL score was significantly higher for those vaccinated ( $10.8 \pm 1.8$ ) versus those not vaccinated ( $10.2 \pm 2.1$ ) ( $p < .0001$ ).

Multivariable logistic regression model (C-statistic: 0.78) showed that the odds of having received at least one dose of HPV vaccination increased by 13% for every unit increase in health literacy score (OR:1.13, 95% CI: 1.06–1.21,  $p < .0001$ ) after controlling for other independent variables. Those who had any kind of health insurance coverage (OR:1.61, 95% CI: 1.14–2.27,  $p = .006$ ) and a regular personal doctor or health care provider when needed (OR:1.38, 95% CI: 1.08–1.77,  $p = .01$ ) were significantly more likely to have had an HPV vaccination respectively compared to their counterparts. Educational level did not predict HPV vaccination (Table 3).

## Discussion

To our knowledge, this is the first study to use a population-level representative sample to understand the association between health literacy and receipt of HPV vaccination among adults of ages 18 to 32 years. BRFSS, for the first time, included an optional health literacy module in 2016, which makes it easier to derive population-level estimates for health literacy and various other health conditions, health outcomes, and access to care indicators. We found a significant positive association between higher health literacy levels and receiving at least one dose of HPV vaccination. Other studies using the 2016 BRFSS data and the HL questions found similar associations between HL and other health conditions and health outcomes. For example,

**Table 1.** Characteristics of the overall study sample.

Characteristic	(N = 6,731) <sup>a</sup>
<b>Age (n = 6155)</b>	
18 to 25	3296 (53.6%)
26 to 32	2859 (46.4%)
<b>Gender (n = 6731)</b>	
Female	3474 (51.6%)
Male	3257 (48.4%)
<b>Marital Status (n = 6708)</b>	
Married/Partnered	2183 (32.5%)
Separated/Widowed/Divorced/ Never married	4525 (67.5%)
<b>Race/ethnicity (n = 6664)</b>	
Hispanics	899 (13.5%)
Multiracial Hispanic	428 (6.4%)
Non-Hispanic Black	802 (12.0%)
Non-Hispanic Other	540 (8.1%)
Non-Hispanic White	3995 (60.0%)
<b>Educational status (n = 6725)</b>	
Less than 12 <sup>th</sup> grade	458 (6.8%)
Grade 12 <sup>th</sup> or GED	2075 (30.9%)
Some college or technical school	2384 (35.4%)
College graduate	1808 (26.9%)
<b>Household income level. (n = 5594)</b>	
\$20,000 or less	1198 (21.4%)
\$21,000 to \$50,000	2337 (41.8%)
More than \$50,000	2059 (36.8%)
<b>Ability to get advice or information about health topics (n = 2608)</b>	
Very easy	1932 (74.1%)
Somewhat easy	568 (21.8%)
Somewhat difficult	87 (3.3%)
Very difficult	21 (0.8%)
<b>Understanding information provided by health care providers (n = 2819)</b>	
Very easy	1730 (61.4%)
Somewhat easy	926 (32.8%)
Somewhat difficult	136 (4.8%)
Very difficult	27 (1.0%)
<b>Understanding written health information (n = 2596)</b>	
Very easy	1681 (64.8%)
Somewhat easy	754 (29.0%)
Somewhat difficult	141 (5.4%)
Very difficult	20 (0.8%)
<b>Any kind of health care coverage (n = 6663)</b>	
Yes	5498 (82.5%)
No	1165 (17.5%)
<b>Have access to a personal doctor or a health care provider (n = 6694)</b>	
Yes	4203 (62.8%)
No	2491 (37.2%)
<b>Had HPV Vaccination (n = 6725)</b>	
Yes	1762 (26.2%)
No	4963 (73.8%)

<sup>a</sup>- Not all subcategories add to overall sample size due to missing values.

significantly more unhealthy behaviors and lower health literacy levels were found in adults with prediabetes than adults without prediabetes.<sup>27</sup> Another study utilizing 2016 BRFSS data found that those with three or more chronic health conditions were 65% more likely to have low HL than those with no chronic diseases.<sup>28</sup> These studies further validate the importance of understanding the HL levels of population groups and its association to overall health conditions and outcomes. This study's findings and previous studies warrant a multi-sectorial effort comprising health care and public health organizations, health professionals, policymakers, communities, families, and individuals to improve the health literacy of the people and the community they live in.<sup>29</sup> Developing and disseminating accurate and straightforward information regarding the HPV vaccine by crucial health and public health organizations is essential to improve health literacy levels of the public about the vaccine, its purpose, and safety.

Self-reported health literacy levels in our population group were high. This is a skewed HL score distribution with slight variance in the HL scores. There could be a few reasons for this uneven distribution. The respondents may not have been aware of their HL skills. In addition, they may have inflated their HL levels due to social desirability bias. Previous literature<sup>30</sup> has shown that when asked about their self-perceived HL levels, most respondents overestimate their HL levels compared to when HL is measured using a valid and reliable instrument.

The bivariate analyses showed that all the individual HL variables were significantly associated with receiving at least one dose of the HPV vaccine. The three HL variables measure different literacies and are equally important for health outcomes. Therefore, we created a composite variable by summing up the responses for these three measures and included it as the main predictor of HPV vaccination. This new variable was

**Table 2.** Human papilloma virus vaccination demographics for adults aged 18 to 32 years.

Characteristic	Vaccinated (n = 1,762)	Not vaccinated (n = 4,963)	p-value
<b>Age</b>			
18 to 25	1089 (33.0%)	2207 (67.0%)	<0.0001*
26 to 32	507 (17.7%)	2352 (82.2%)	
<b>Gender</b>			
Female	1370 (39.4%)	2104 (60.6%)	<0.0001*
Male	392 (12.0%)	2865 (88.0%)	
<b>Marital Status</b>			
Married/Partnered	478 (21.9%)	1705 (78.1%)	<0.0001*
Separated/Widowed/Divorced/ Never married	1281 (28.3%)	3244 (71.7%)	
<b>Race/ethnicity</b>			
Hispanics	200 (22.3%)	699 (77.7%)	<0.02*
Multiracial Hispanic	120 (28.0%)	308 (72.0%)	
Non-Hispanic Black	230 (28.7%)	572 (71.3%)	
Non-Hispanic Other	137 (25.4%)	403 (74.6%)	
Non-Hispanic White	1068 (26.7%)	2927 (73.3%)	
<b>Educational status</b>			
Less than 12 <sup>th</sup> grade	76 (16.6%)	382 (83.4%)	<0.0001*
Grade 12 <sup>th</sup> or GED	423 (20.4%)	1652 (79.6%)	
Some college or technical school	748 (31.4%)	1636 (68.6%)	
College graduate	515 (28.5%)	1293 (71.5%)	
<b>Household income level</b>			
\$20,000 or less	331 (27.6%)	867 (72.4%)	<0.02*
\$21,000 to \$50,000	579 (24.8%)	1758 (75.2%)	
More than \$50,000	583 (28.3%)	1476 (71.7%)	
<b>Ability to get advice or information about health topics</b>			
Very easy	553 (28.6%)	1379 (71.4%)	0.004*
Somewhat easy	121 (21.3%)	447 (78.7%)	
Somewhat difficult	20 (23.0%)	67 (77.0%)	
Very difficult	4 (19.0%)	17 (81.0%)	
<b>Understanding information provided by health care providers</b>			
Very easy	503 (29.1%)	1227 (70.9%)	<0.0001*
Somewhat easy	200 (21.6%)	726 (78.4%)	
Somewhat difficult	20 (14.7%)	116 (85.3%)	
Very difficult	5 (18.5%)	22 (81.5%)	
<b>Understanding written health information</b>			
Very easy	493 (29.3%)	1188 (70.7%)	0.0002*
Somewhat easy	169 (22.4%)	585 (77.6%)	
Somewhat difficult	26 (18.4%)	115 (81.6%)	
Very difficult	3 (15.0%)	17 (85.0%)	
<b>Any kind of health care coverage</b>			
Yes	1571 (28.6%)	3927 (71.4%)	<0.0001*
No	180 (15.5%)	985 (84.5%)	
<b>Have access to a personal doctor or a health care provider</b>			
Yes	1300 (30.9%)	2903 (69.1%)	0.005*
No	456 (18.3%)	2035 (81.7%)	

\* – statistically significant.

significantly associated with HPV vaccination, indicating that a combined higher health literacy score was crucial for receiving at least one dose of HPV vaccination.

Numerous factors have been shown to influence the likelihood of receiving the HPV vaccine, including but not limited to age,<sup>31</sup> race,<sup>32,33</sup> gender,<sup>34</sup> maternal education,<sup>14</sup> primary care provider access,<sup>15</sup> health insurance,<sup>15</sup> socioeconomic status,<sup>15</sup> and parental apprehensions.<sup>35</sup> Some of these factors are modifiable and some are non-modifiable. Our study identified the importance of health literacy, a relatively easily modifiable variable, in HPV vaccination uptake. Additionally, the lack of awareness about the safety of the HPV vaccine and the risks associated with HPV infection is the underlying reason for disparities in vaccination rates. Here, we explore some factors and the underlying link to poor health literacy.

There were many exciting findings related to HPV vaccination prevalence and factors that predict receipt of at least one dose of HPV vaccination worth mentioning. As mentioned previously, the prevalence of at least one dose of HPV

vaccination was extremely low at 26%, which is concerning. The ACIP has recommended HPV vaccination for female adolescents since 2006 and for male adolescents since 2009. Yet the vaccine coverage remains very low compared to other vaccines. The low vaccination prevalence rates increase the potential for HPV infection among adolescents and young adults. There were significant differences in vaccine coverage by age. While a third (33%) of those aged 18–25 years were vaccinated, the coverage dropped to 17.7% among those 26–32 years. Our study's slightly higher prevalence in 18- to 25-year-olds is understandable because ACIP recommends routine vaccination among this age group. However, a prevalence of only 33% in this age group is still very low, though better than other national surveys.<sup>31,36</sup> Reports based on the National Health Interview Survey and National Immunization Survey–Teen (NIS-Teen) among adolescents found higher vaccination rates among older adolescents.<sup>36</sup> The National Health Interview Survey reported a steady increase in the vaccine coverage for HPV over the last few years from 20.7% in 2010

**Table 3.** Multivariable logistic regression model predicting HPV vaccination status among adults 18 to 32 years.

Characteristic	Odds Ratio (95% CI)	p-value
<b>Age</b>		
26 to 32	0.39 (0.27–0.43)	<0.0001*
18 to 25	Reference	
<b>Gender</b>		
Female	6.46 (5.01–8.32)	<0.0001*
Male	Reference	
<b>Marital Status</b>		
Married/Partnered	0.68 (0.53–0.88)	0.003 *
Separated/Widowed/Divorced/ Never married	Reference	
<b>Race/ethnicity</b>		
Hispanics	0.71(0.46–1.10)	0.1
Multiracial Hispanic	2.55 (1.21–5.38)	0.01 *
Non-Hispanic Black	1.14 (0.83–1.57)	0.4
Non-Hispanic Other	1.95 (1.10–3.35)	0.02 *
Non-Hispanic White	Reference	
<b>Educational status</b>		
Grade 12 <sup>th</sup> or GED	0.84 (0.48–1.10)	0.5
Some college or technical school	1.15 (0.66–1.99)	0.6
College graduate	0.80 (0.44–1.41)	0.4
Less than 12 <sup>th</sup> grade	Reference	
<b>Household income level</b>		
\$21,000 to \$50,000	1.10 (0.81–1.43)	0.6
More than \$50,000	1.41 (1.03–1.93)	0.03*
\$20,000 or less	Reference	
<b>Health literacy score (higher number)</b>	1.13 (1.06–1.21)	<0.0001*
<b>Any kind of health care coverage</b>		
Yes	1.61 (1.14–2.27)	0.006 *
No	Reference	
<b>Have access to a personal doctor or a health care provider</b>		
Yes	1.38 (1.08–1.77)	0.01 *
No	Reference	

Abbreviations: CI = confidence interval.

\* – statistically significant.

to 52.8% in 2018 among females aged 19–26 years and from 2.1% in 2011 to 26.3% in 2018 among males aged 19–26 years. An increase in coverage was also noted among adolescents (13–17 years) by the NIS-Teen.<sup>31</sup>

Previous literature shows conflicting evidence about racial and ethnic disparities in HPV vaccination. In one study, the authors studying 19- to 26-year-old women determined that non-Hispanic black, Hispanic, and Non-Hispanic Asian women were significantly less likely to have received HPV vaccination than non-Hispanic women.<sup>32</sup> However, in another study, Hispanic adolescents and adolescents from other races, including Asians, were significantly more likely to get vaccinated for HPV than non-Hispanic White adolescents.<sup>33</sup> In our study, adults from ethnic minority groups (except for Hispanics) were significantly more likely to be vaccinated for HPV than non-Hispanic White adults. This finding shows that the gap in racial and ethnic disparities in receiving at least one dose of HPV vaccination has slightly reduced, which is encouraging.

In our study, females were six-times more likely to have received the HPV vaccine than males in the cohort. This finding is similar to previous studies and reports. A CDC report from based on the National Health Interview Survey,<sup>34</sup> also found a large difference in male vs. female vaccination rates. This gap in vaccination rates for girls and boys has declined slightly over the years but it still persists. The CDC report

postulates that the difference may be because the recommendations for vaccination was issued earlier for girls than boys. Greater awareness about cervical cancer than other types of cancers caused by HPV may also be a reason for the differences in the vaccine rates.

Parental misconceptions and inhibitions to vaccination are important reasons for lower levels of HPV vaccination. Another CDC report, based on results from a large survey of approximately 39,000 parents of teens that were not vaccinated, found that the top five selected reasons to decline vaccination for children were: “Safety concerns,” “Not recommended,” “Lack of knowledge,” “Not sexually active,” “Not needed or not necessary.”<sup>35</sup> One of the other reasons often cited by parents is that HPV vaccination may increase sexual activity among children. These apprehensions have been shown to be misplaced and underline the importance of the role of health literacy and awareness in vaccination. The HPV vaccine is most effective in preventing cancers when administered prior to the first sexual experience. Hence, it is recommended to receive HPV vaccination in early adolescence (age 11–12 years).<sup>9</sup> The need for parental consent for vaccination at this age may have an adverse impact on vaccination rates in this population. Hence, the lack of awareness or low health literacy levels of parents strongly influences vaccination rates among children.

## Limitations

This study is not without limitations. BRFSS data relies on self-reporting, leading to measurement or recall bias. As previously stated, due to social desirability bias, respondents may have inflated their responses to HL, which could overestimate HL levels. HL questions can be very subjective and may elicit responses that vary from one individual to another. Because of the cross-sectional nature of the BRFSS, it is impossible to determine the causal nature of HL toward HPV vaccination.

The HL module was administered only in 17 states and territories, which restricted us in data analysis and the generalizability of the findings. Studies on regional variation in HPV vaccination rates have reported conflicting results with some studies reporting a variation while others reporting no differences.<sup>37,38</sup> The rates have generally been reported to be lower in poorer states and the states in the south where vaccine hesitancy rates are higher. We did not examine the effect of regional variation in this study, some of the states included in the BRFSS are in the south and this may have affected our results.

## Conclusions

This study shows that HL is an important contributing factor to HPV vaccine uptake as individuals with overall higher HL scores were more likely to receive at least one dose of the vaccine. Health literacy is a relatively easily modifiable determinant of health. Hence, health care and public health organizations, health care professionals, and policymakers should emphasize improving the health literacy levels of the patients and the public to increase the uptake of the HPV vaccine.

## Disclosure statement

No potential conflict of interest is reported by the author(s).

## Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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