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The association between internet use to obtain health information and receiving three doses of the Hepatitis B vaccine in a multi-ethnic population in Ohio

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ABSTRACT

While most cancer incidence and mortality rates are decreasing, liver cancer rates are increasing. The Hepatitis B Virus (HBV) vaccine prevents liver cancer, although not everyone receives all three doses of the vaccine. This study examined the association between using the internet as the primary source of health information and receiving three HBV vaccine doses among a multi-ethnic population in Ohio. From May 2017 through February 2018, participants in the Community Initiative Towards Improving Equity and Health Status (CITIES) study reported their primary health information source and if they received three HBV vaccine doses. A multivariable logistic regression model was fit using backwards selection. Overall, 26.6% received three HBV vaccine doses. After adjusting for race/ethnicity and education, the association between internet use and receiving three HBV vaccine doses was not significant (p-value = 0.73). In the process of model-building, race/ethnicity and educational attainment were identified as factors associated with completing the HBV vaccine; Hispanics (OR = 0.35; 95% CI = 0.17, 0.69) and African Americans (OR = 0.53; 95% CI = 0.35, 0.81) had lower odds of receiving three doses compared to whites; compared to college graduates, those with a high school diploma or less also had lower odds (OR = 0.33; 95% CI = 0.21, 0.52). This study suggests no association between internet use and complete HBV vaccination; however, associations between both race/ethnicity and educational attainment and HBV vaccine completion were identified. Future research should consider factors that stem from racial/ethnic and educational disparities that may influence adherence to HBV vaccination (i.e., healthcare system mistrust, access to accurate health information).

1. Introduction

Cancer is the one of the leading causes of death in nearly every region of the world (Torre et al., 2016). In 2022, approximately 1.9 million new cases of cancer will be diagnosed in the United States (U.S.) and more than 609,000 people will die from cancer (Cancer Facts & Figures, 2022). From 1992 to 2017, cancer rates in the U.S. have been decreasing. However, this trend is not apparent for all cancers, as incidence and mortality rates of liver cancer have been steadily increasing over the last few decades (Howlader et al., 2020). Liver cancer mortality rates increased by 84% from 1990 to 2017. Furthermore, in 2010, more than half of the deaths associated with liver cancer were attributed to infection with hepatitis B virus (HBV) (Howlader et al., 2020).

Hepatitis B, which is caused by HBV, is now the chronic viral infection with the highest incidence worldwide and is considered one of the world's top ten health priorities. (Trépo et al., 2014). HBV can be transmitted during childbirth, sexual activity, unsafe injections and medical procedures (Oakes, 2014). HBV can and continues to be

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transmitted to people of all ages, races/ethnicities, and cultures. Those who are most at risk of infection include foreign-born residents in the U. S., racial minorities, the elderly, those with other sexually transmitted infections, those who have multiple sex partners, and men who have sex with other men (Trépo et al., 2014; Bhuiyan et al., 2020). If HBV is left untreated in an individual, further complications, including liver cancer, arise.

The link between HBV and liver cancer is both clear and significant. A study of 22,707 men in Taiwan found that up to 40% of men and 15% of women who contracted HBV from their mother in childbirth would die of liver cancer or cirrhosis (Trépo et al., 2014; Beasley et al., 1981). To attempt to control HBV infection, the HBV vaccine was approved in 1981 in the United States (Trépo et al., 2014), on a three dose schedule. By 1991, a recommendation was submitted by the Centers of Disease Control and Prevention (CDC) to adopt the practice of administering the HBV vaccine to all infants born in the United States, because no other efforts had been highly effective (Bhuiyan et al., 2020; Centers for Disease Control and Prevention, 1991). Now, nearly 40 years have passed since the approval of the HBV vaccine in the United States, and government promotion of the HBV vaccine has increased drastically.

In 1995, the United States began routinely vaccinating children who had not yet received the HBV vaccine, and in 1999, a recommendation was submitted to vaccinate all children under the age of 19 who had not previously received the HBV vaccine (Bhuiyan et al., 2020). The current guidelines for HBV vaccination recommend that children receive their first dose on the day they are born, their second dose one month later, and their third and final dose six months following the second (Centers for Disease Control and Prevention, 1991). Although the vaccine is recommended for newborns, in 2017, 10.1% of infants born in hospitals were not vaccinated (Nitsch-Osuch et al., 2020). In addition, the CDC reported that in the Unites States, only approximately 25% of high-risk adults, such as racial minorities, individuals with multiple sexual partners, men who have sex with men, and newborns whose mothers are infected, get vaccinated (Bhuiyan et al., 2020). Thus, as many as 75% of high-risk individuals are not adhering to a vaccination schedule that is proven to prevent both HBV and liver cancer (Trépo et al., 2014).

It is still unclear exactly why such a vast number of individuals in the United States and across the world have not received all three doses of the HBV vaccine. Factors such as age, gender, race/ethnicity, and place of residence have all been studied as potentially associated with vaccination adherence (Bhuiyan et al., 2020; Misra et al., 2013). As government and health organizations continue to promote the HBV vaccine, people of all ages, genders, races/ethnicities, and regions will want and need to make well-informed decisions about vaccination. Where individuals go for medical information and advice could be one potential reason that HBV vaccine rates remain suboptimal.

Individuals obtain information about health, including how to make vaccination decisions, through different channels. While individuals look to their physicians with questions about healthcare, nearly 70% of people look to the internet as their first source for health-related questions (Ihler and Canis, 2019). Internet content, however, does not always provide accurate or balanced information, and in the case of vaccinations in general, may often provide false or misleading information. A recent study analyzing google searches in the U.S., Canada, and Europe suggests that people who lack a more complete understanding of vaccinations, are less likely to use medical terms while searching for information, and as a result, are much more likely to find anti-vaccination websites containing false information (Betsch, 2011). This same study also suggests that fear of adverse risks from immunizations increased for those who had accessed anti-vaccination websites and that their fear of adverse risks from not immunizing decreased, over a period of five months (Betsch, 2011).

Although research suggests that the use of the internet interferes with an individual's perception of vaccinations and accompanying risks, the association between internet use and HBV adherence remains unclear. Due to the increasing mortality rate of HBV-associated liver cancer, it is important that further research be conducted on the effects of the internet and the possible dangers it imparts in relation to adherence to the HBV vaccination schedule, especially in populations at higher risk for HBV infection and liver cancer. The goal of this study was to examine the use of the internet as the primary source of health information and the association with receiving all three doses of the HBV vaccine among a multi-ethnic population of survey respondents in Ohio, including immigrants. We hypothesized that individuals who use the internet as their primary source for healthcare information were less likely to receive all three doses of the HBV vaccine.

2. Methods

2.1. Setting

The Ohio State University Comprehensive Cancer Center (OSUCCC) collected the data used in this study as part of the Community Initiative Towards Improving Equity and Health Status (CITIES) project. The goal of CITIES was to better understand and define the catchment area of the OSUCCC, which consists of the entire state of Ohio. By understanding the catchment area, the OSUCCC can better understand the reasons for health disparities among the many catchment area populations. The survey was developed in conjunction with the National Cancer Institute (NCI) and other cancer centers as part of an initiative, the Population Health Assessment Supplements. To construct the survey, previous surveys conducted by the OSUCCC were reviewed, as well as nationwide surveys such as the National Health Interview Survey (NHIS) (National Health Interview Survey, 2005), the Behavioral Risk Factor Surveillance System (BRFSS) (Behavioral Risk Factor Surveillance System Survey Questionnaire, 2019), and the Health Information National Trends Survey (HINTS) (Nelson et al., 2004). The survey used in this study consisted of questions about demographics, health habits, medical and family medical history, and cancer beliefs. CITIES and selected results have been discussed in detail in previous reports (Paskett et al., 2019). The Ohio State University (OSU) Institutional Review Board approved this study in February of 2017 and the survey was administered from May 30, 2017, to February 16, 2018.

2.2. Participant eligibility and recruitment

Residents of Ohio 21–74 years of age were eligible to participate in this study. In order to ensure that the participants were made up of a diverse group of underrepresented populations, two recruitment strategies were conducted concurrently. The first, provided by Marketing Systems Group, used a random selection from a list of commercial and residential United States Postal Service addresses, and the white pages, to recruit white individuals from urban, rural and Appalachian Ohio. The second strategy, used to ensure the inclusion and participation of minority groups, included collaborations with partners in the community. Participants were recruited via email (n = 322), phone (n = 311), and in-person community events (n = 315). The sample had a variety of population groups represented such as Asian, African American, Somali, Hispanic, and white (urban and rural) that were then categorized by age group (21–40; 41–50; 51–65; and 66–74 years) to fill pre-determined cell counts. Informed verbal consent was then obtained for every participant. Data collection was completed by community health workers according to the needs of the participants, using various techniques including phone calls, interviews, and web surveys. The questionnaire and phone calls were available in English, Chinese, Somali and Spanish languages. Research Electronic Data Capture (REDCap), a secure data collection application, was utilized through OSU for data collection and management (Harris et al., 2009).

2.3. Outcome of interest

The outcome of interest was adherence to receiving at least three

doses of the HBV vaccine. While completing the survey, participants were first asked, "Have you ever received the hep B vaccine?" with "yes," "no," and "don't know" as possible answers. Those who answered "yes" were then asked, "Have you received at least three doses?" with the same response options. The responses were dichotomized, and any response of "no" or "don't know" was categorized as not having received at least three doses of the HBV vaccine.

2.4. Primary exposure

The primary exposure in this project was using the internet as the primary source for healthcare information. The first question asked, "Have you ever looked for information about health or medical topics from any source?," with response options of "yes," "no," and "don't know." Those who answered yes to this question were then asked: "the most recent time you looked for information about health or medical topics, where did you go first?" with several responses such as "books," "brochures, pamphlets, etc.," "cancer organization," "family," "friend/coworker," "doctor or healthcare provider," "internet," "library," "magazines," "newspapers," "telephone information number," "complementary, alternative, or unconventional practitioner," "social media site, such as Facebook, PatientsLikeMe, Caring Bridge," "other," "don't know," and "prefer not to answer." Respondents who provided an answer other than "internet" were categorized as not using the internet.

2.5. Covariates of interest

Self-reported demographics of interest included gender (male, female), race/ethnicity (white, Asian, African American, Somali, or Hispanic); education (high school or less, some college or technical school, or college graduate); smoking status (never smoked, former smoker or current smoker); political party (Republican, Democrat or Independent/other); locale (Appalachian, rural non-Appalachian, or urban non-Appalachian); marital status (married/living as married, divorced/widowed/separated, or single/never married); and age (continuous). In addition to the categories described above, response choices of 'don't know' and 'prefer not to answer' were available. Participants were also asked whether they agreed or disagreed with the following, "There's not much you can do to lower your chances of getting cancer," and "When I think about cancer, I automatically think about death." with response options of: "strongly agree," "somewhat agree," "somewhat disagree," "strongly disagree," "don't know," and "prefer not to answer." The answers were then collapsed into the categories, "agree" and "disagree."

2.6. Analysis

Summary statistics (means and standard deviations or frequencies) were calculated for the outcome and all covariates. Chi-square tests of association were used to test the relationship between the HBV vaccination outcome and primarily using the internet to obtain health information (dichotomous). For chi-square tests, alpha was set at 0.05. Univariable logistic regression was used to evaluate the association of the covariates on the outcome. A final multivariable logistic model was created using a backwards elimination approach to identify potential confounders, following the selection process of Mickey and Greenland (Mickey and Greenland, 1989). First, a model was fit using all of the covariates of interest and the internet use exposure. Next, predictors were eliminated one at a time and the impact on the model coefficient corresponding to the internet use predictor was calculated. The predictor with the smallest impact was eliminated and the process was repeated until the only variables remaining in the model were those whose elimination would result in a 20% change in the internet use coefficient. As locale (Appalachian, rural non-Appalachian, urban non-Appalachian) was assigned at a county level, all models including this predictor included a random effect for county.

3. Results

3.1. Study population

Overall, after excluding those with responses of "don't know" or "prefer not to answer" (n = 81), 26.6% of 867 respondents received at least three doses of the HBV vaccination. The demographics of participants are shown in Table 1. The mean age of participants was 50.8 years. The population sample was predominantly female (62.8%). The sample was 6.3% Somali, 6.3% Asian, 12.5% Hispanic, 21.3% African American, and 53.7% White. Almost a quarter (24.1%) of the participants were born outside of the United States. The sample was 35.1% Democrat and 22.1% Republican, while 24.1% were Independent or members of

Table 1
Demographic characteristics of Ohio participants in the CITIES project in 2017 and 2018 according to receipt of three or more doses of the Hepatitis B vaccine (N = 867).

	Three or More doses of Hep B Vaccine		
	No (N = 636) N (%)	Yes (N = 231) N (%)	Total (N = 867) N (%)
Age, years (Mean)	51.8	48.0	50.8
Gender	252 (78.3)	70 (21.7)	322 (37.2)
Male			
Female	383 (70.4)	161 (29.6)	544 (62.8)
Race/Ethnicity			
Hispanic	97 (89.8)	11 (10.2)	108 (12.5)
Somali	47 (87.0)	7 (13.0)	54 (6.3)
Asian	36 (66.7)	18 (33.3)	54 (6.3)
African American	145 (78.8)	39 (21.2)	184 (21.3)
White	308 (66.4)	156 (33.6)	464 (53.7)
Born in the United States			
Yes	458 (70.4)	193 (29.6)	651 (75.9)
No	172 (83.1)	35 (16.9)	207 (24.1)
Political Party Preference			
Don't know/Refused/Skipped	138 (85.2)	24 (14.8)	162 (18.7)
Republican	125 (65.1)	67 (34.9)	192 (22.1)
Democrat	214 (70.4)	90 (29.6)	304 (35.1)
Independent/Other	159 (76.1)	50 (23.9)	209 (24.1)
Educational Attainment			
High School or Less	230 (87.8)	32 (12.2)	262 (30.6)
Technical School/Some College	164 (68.9)	74 (31.1)	238 (27.8)
College Graduate	231 (64.9)	125 (35.1)	356 (41.6)
Marital Status			
Married/Living as Married	394 (71.1)	160 (28.9)	554 (64.4)
Divorced/Widowed/Separated	129 (76.8)	39 (23.2)	168 (19.5)
Single/Never Married	109 (79.0)	29 (21.0)	138 (16.0)
Smoking Status			
Never Smoker	405 (72.6)	153 (27.4)	558 (67.0)
Former Smoker	136 (74.3)	47 (25.7)	183 (22.0)
Current Smoker	68 (73.9)	24 (26.1)	92 (11.0)
Locale			
Appalachian	140 (64.8)	76 (35.2)	216 (24.9)
Rural non-Appalachian	101 (64.7)	55 (35.3)	156 (18.0)
Urban non-Appalachian	395 (79.8)	100 (20.2)	495 (57.1)
There's not much you can do to lower your chances of getting cancer			
Agree	155 (86.1)	25 (13.9)	180 (22.7)
Disagree	415 (67.7)	198 (32.3)	613 (77.3)
When I think about cancer, I automatically think about death.			
Agree	345 (76.0)	109 (24.0)	454 (54.4)
Disagree	261 (68.7)	119 (31.3)	380 (45.6)
The most recent time you looked for information about health or medical topics, you went to the internet.			
Yes	253 (67.1)	124 (32.9)	377 (43.5)
No	383 (78.2)	107 (21.8)	490 (56.5)

another political party. Educational attainment varied, with 30.6% having a high school diploma or less, 27.8% having completed technical school or some college, and 41.6% being college graduates. A majority of the respondents (64.4%) classified themselves as married or living as married, 19.5% as divorced, widowed, or separated, and the remaining 16.0% as single, never married. The vast majority (67.0%) of participants reported that they had never smoked, while 22.0% reported being former smokers, and 11.0% reported current smoking. The participants reported living in Appalachia (24.9%), rural non-Appalachia (18.0%), and urban non-Appalachia (57.1%). Participants also reported on their cancer beliefs, with 22.7% agreeing that "there's not much you can do to lower your chances of getting cancer," 54.4% of respondents agreeing that "when I think about cancer, I automatically think about death," and 43.5% of participants indicated that the internet was the last source they went to when seeking information about health and medical care.

3.2. Univariable modeling

Univariable logistical regression results are shown in Table 2. A significant association was found between the primary exposure, using the internet as a source for health information, and having received at least three doses of the HBV vaccine (OR: 1.75; 95% CI: 1.30, 2.38; p-value = 0.0003). Additional univariable results illustrate interesting findings which may be explored in future studies.

3.3. Multivariable modeling

After adjusting for race/ethnicity and education in the multivariable model, the association between internet use and adhering to the HBV vaccine was no longer significant (OR = 1.06; 95% CI = 0.76, 1.48; p-value = 0.73). Table 3 shows the final model resulting from the backwards selection approach and the significance of associations between race/ethnicity and HBV vaccine adherence (p-value = 0.0033) and educational attainment and HBV vaccine adherence (p-value < 0.0001). After adjusting for internet use and educational attainment, Hispanics had 0.35 times the odds of completing HBV vaccination compared to whites (95% CI = 0.17, 0.69) and African Americans had 0.53 times the odds compared to whites (95% CI = 0.35, 0.81). Those having a high school diploma or less had 0.33 times the odds of completing HBV vaccination when compared to college graduates (95% CI = 0.21, 0.52).

4. Discussion

While cancer rates for most cancer sites and types have been declining for the last two decades, incidence rates of liver cancer have steadily increased (Howlader et al., 2020). Widespread uptake of the HBV vaccine would result in an overall decline in liver cancer rates. Although the HBV vaccine has been implemented in the United States for decades, not all segments of the population (i.e. African Americans) have received the vaccine uniformly (Bhuiyan et al., 2020). Individuals decide to vaccinate based on a number of factors, including government policies, cultural norms, access to adequate healthcare, and an understanding of the benefits of vaccinating (MacDonald, 2015). The goal of this study was to examine the potential association between use of the internet as an individual's primary source of health information and receiving at least three doses of the HBV vaccine among a multi-ethnic population in Ohio. This study also examined the association between demographic factors and receiving at least three HBV vaccine doses.

The results from the univariable logistic regression model showed an association between internet use and HBV vaccination adherence. Initially, the data indicated that those who used the internet as their primary source for medical information were significantly more likely to receive three doses of the HBV vaccine. However, in the multivariable model, adjusted for race/ethnicity and educational attainment, there was no significant association between using the internet as the primary source for medical information and receiving at least three doses of the

Table 2
Univariable logistic regression results for CITIES participants in Ohio in 2017 and 2018 receiving three or more doses of the Hepatitis B vaccine.

	Odds Ratio (95% CI)	P-value
Age	0.98 (0.97, 0.99)	0.0006
Gender	0.66 (0.48, 0.91)	0.01
Male		
Female	1.00	
Race/Ethnicity		
Hispanic	0.22 (0.12, 0.43)	<0.0001
Somali	0.29 (0.13, 0.67)	
Asian	0.99 (0.54, 1.79)	
African American	0.53 (0.36, 0.79)	
White	1.00	
Born in the United States		
Yes	1.00	0.0004
No	0.48 (0.32, 0.72)	
Political Party Preference		
Don't know/Refused/Skipped	0.55 (0.32, 0.95)	0.0002
Republican	1.70 (1.10, 2.63)	
Democrat	1.34 (0.89, 2.00)	
Independent/Other	1.00	
Educational Attainment		
High School or Less	0.26 (0.17, 0.39)	<0.0001
Technical School/Some College	0.83 (0.59, 1.18)	
College Graduate	1.00	
Marital Status		
Married/Living as Married	1.53 (0.97, 2.39)	0.10
Divorced/Widowed/Separated	1.14 (0.66, 1.96)	
Single/Never Married	1.00	
Smoking Status		
Never Smoker	1.07 (0.65, 1.77)	0.88
Former Smoker	0.98 (0.55, 1.73)	
Current Smoker	1.00	
Locale		
Appalachian	1.36 (0.81, 2.30)	0.43
Rural non-Appalachian	1.34 (0.79, 2.29)	
Urban non-Appalachian	1.00	
There's not much you can do to lower your chances of getting cancer.		
Agree	0.34 (0.21, 0.53)	<0.0001
Disagree	1.00	
When I think about cancer, I automatically think about death.		
Agree	0.69 (0.51, 0.94)	0.02
Disagree	1.00	
The most recent time you looked for information about health or medical topics, you went to the internet.		
Yes	1.75 (1.30, 2.38)	0.0003
No	1.00	

Table 3
Multivariable logistic regression results for CITIES participants in Ohio in 2017 and 2018 receiving three or more doses of the Hepatitis B vaccine.

	Adjusted Odds Ratio (95% CI)	P-value
Race/Ethnicity		
Hispanic	0.35 (0.17, 0.69)	0.003
Somali	0.55 (0.23, 1.31)	
Asian	0.87 (0.47, 1.61)	
African American	0.53 (0.35, 0.81)	
White	1.00	
Educational Attainment		<0.0001
High School or Less	0.33 (0.21, 0.52)	
Technical School/Some College	0.96 (0.67, 1.39)	
College Graduate	1.00	
The most recent time you looked for information about health or medical topics, you went to the internet.		
Yes	1.06 (0.76, 1.48)	
No	1.00	0.73

HBV vaccine. This conclusion contradicts a previous study that found a relationship between internet use and vaccination adherence (Betsch, 2011). This could be due to a number of factors, including selection bias in this sample, different cultures and government policies (i.e. mandated vaccines), the way internet use was measured in their study vs our study (i.e. Betsch's study observed which web pages individuals found when searching for vaccine information on google while this study looked at the results of a self-reported survey) and the fact that our study focused on the HBV vaccine, compared to vaccinations in general.

Although our hypothesis was not supported, other findings of this study showed that both race/ethnicity and education had significant associations with adherence to HBV vaccination. African Americans and Hispanics were much less likely to receive at least three doses of the Hepatitis B vaccine, when compared to white individuals, and those with high school diplomas or less were far less likely to have received three doses of the HBV vaccine, when compared to college graduates. This may be because race/ethnicity and educational attainment affect an individual's perspective. For example, educational attainment is associated with healthcare literacy, which directly affects one's ability to comprehend the importance of vaccinations (Kutner et al., 2006; Hersh et al., 2015). Additionally, more educated individuals are more likely to understand their doctor's health recommendations (i.e. to vaccinate) and to adhere to them (Hersh et al., 2015). As a result, when race/ethnicity and educational attainment were included in the multivariable model, the effect of internet use on HBV vaccination was attenuated.

These findings support a recent study that found lower rates of HBV vaccination adherence to be associated with lower educational attainment (LaMori et al., 2022). Our results also support previous research conducted in different locations and with different populations that highlights the lower HBV vaccination coverage among Hispanics and African Americans when compared to whites (Bhuiyan et al., 2020). Mistrust of the healthcare system among African Americans may explain these racial differences in vaccine adherence (Otanez and Torr, 2018).

4.1. Strengths and Limitations

This study had a variety of strengths, specifically the survey techniques that aided in recruitment of many understudied populations, namely, racial and ethnic minorities. The survey also applied a strong theoretical framework, based on the Social Determinants of Health. Limitations have also been noted, particularly the small sample size and method of collection for some groups such as the Somali and Asian populations (i.e., by identifying community events and venues). These are small, specific populations and provide insight about the catchment area; however, they may limit the overall generalizability of the study. An additional limitation of this study includes bias associated with self-reporting HBV vaccination. Some of the responses, such as questions about HBV vaccination history may have been inaccurate as a result of bias associated with self-report. Future research should consider a clearer, verifiable method, such as a medical record review, for determining adherence to HBV vaccination guidelines. Another limitation was that it remains unclear whether or not participants always use the internet as a primary source for health information, as the corresponding question refers to the most recent time respondents searched for health information. As the most recent occurrence may not represent all occurrences, future research should consider a more direct survey question, leading to a more definite interpretation and should also consider methods which assess specific internet sources for healthcare information; available information likely varies considerably, ranging from peer-reviewed articles in scientific journals to social media comments.

4.2. Conclusion

This study fills a gap in the literature, as it focused on associations for which little research has been conducted, such as internet use, educational attainment and adherence to the HBV vaccine. This study also aids in confirming the association between race/ethnicity and HBV vaccination. In order to arrive at more conclusive results, future research should consider other possible factors that stem from racial and educational disparities that may influence adherence to vaccination (i.e. mistrust towards the community or the healthcare system, and access to accurate healthcare information). Previous research has shown associations between racial disparities and other vaccinations (i.e. influenza, Human Papillomavirus (HPV) and pneumococcal), and similar methods should be used in future research to determine why these disparities exist (Otanez and Torr, 2018; Tse et al., 2018).

Factors that eliminate or reduce disparities in vaccination adherence should be examined in future studies. For example, HPV and influenza vaccination rates increased when patients received (1) explicit vaccination reminders from providers and (2) calls from outreach workers when they did not have appointments to receive their yearly immunization (Paskett et al., 2016; Humiston et al., 2011). Further, patient navigation, an approach in which patients are personally guided through complex barriers of healthcare, may be successful in increasing HBV vaccination adherence and reducing racial/ethnic and education-related disparities (Freeman, 2006). Healthcare and social workers should work together to raise awareness among racial/ethnic minorities and populations with lower educational attainment, as well as to implement programs that provide consistent reminders and personalized communication to patients who have not received the HBV vaccine.

5. Statements and declarations

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Author Contributions: All authors contributed to the study conception and design. Statistical analyses were performed by Gregory Young. The first draft of the manuscript was written by Cameron Carpenter and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Ethics approval: The Ohio State University (OSU) Institutional Review Board approved this study in February of 2017 and the survey was administered from May 30, 2017, to February 16, 2018.

Consent to Participate: Informed consent was obtained from all

individual participants included in the study.

CRediT authorship contribution statement

Cameron Carpenter: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Brittany Bernardo:** Conceptualization, Data curation, Project administration, Writing – review & editing. **Toyin Adeyanju:** Conceptualization, Data curation, Project administration, Writing – original draft, Writing – review & editing. **Chasity Washington:** Data curation, Project administration, Writing – review & editing. **James L. Fisher:** Investigation, Methodology, Writing – review & editing. **Gregory Young:** Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Electra D. Paskett:** Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Dr. Paskett reports grant funding from the Merck Foundation, Pfizer, Genentech and Guardant Health to the University for work outside the scope of this project. Dr. Paskett is an advisory board member for GSK. Additional authors have no relevant financial or non-financial interests to disclose.

Data availability

Data will be made available on request.

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