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Parent-reported provider recommendation of HPV vaccination among minority adolescents before and during the COVID-19 pandemic: Findings from the National Immunization Survey-Teen, 2019–2021

Chinenye Lynette Ejezie [a,b,*], Paula Cuccaro [a], Casey Durand [a], Lara Savas [a], Ross Shegog [a]

[a] Department of Health Promotion and Behavioral Sciences, UThealth School of Public Health, Houston, TX 77030, USA
[b] Department of Radiation Oncology, The University of MD Anderson Cancer Center, Houston, TX 77030, USA

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ABSTRACT

Provider recommendation of human papillomavirus (HPV) vaccination among adolescents has steadily improved over the years, however, limited research has been conducted to examine if the COVID-19 pandemic disrupted this positive trend in parent-reported provider recommendation among minority adolescents. Therefore, we conducted the present study to determine if there is an association between the pandemic and parent-reported provider recommendation of HPV vaccine among non-Hispanic black and Hispanic adolescents. We also examined whether any changes in parent-reported provider recommendation in the years 2019, 2020, and 2021 differed by race or ethnicity. Using a cross-sectional design to examine data from the National Immunization Survey-Teen (2019–2021), a moderation analysis and logistic regression analysis were performed to model race-specific variation in parent-reported provider recommendation (n = 50,739). We found that Hispanic parents had lower odds (aOR = 0.80 [0.71, 0.91]) of reporting receiving a recommendation compared to non-Hispanic white parents. We also found that the odds of parent-reported provider recommendation were higher in 2020 (aOR = 1.15 [1.03–1.29]) than in 2019. Other variables–age, region, sex, health insurance status, and poverty status–were all associated with parent-reported provider recommendation. These findings demonstrated that the pandemic may not have triggered any race-related gap in the recommendation of HPV vaccines, however, more pandemic-resilient public health efforts are needed to improve parent and provider communication regarding HPV vaccination of adolescents.

1. Introduction

Human papillomavirus (HPV) vaccines have been available since 2006, yet approximately 75% of 13-to-17 year-old adolescents in the United States are partially vaccinated (Pingali et al., 2021), and over 27% remain fully unvaccinated (Walker et al., 2019; Elam-Evans et al., 2020). One of the main determinants of HPV vaccination among adolescents is whether their parents or caregivers receive a recommendation to vaccinate from a health care practitioner (Reiter et al., 2021; Rodriguez et al., 2020; Perkins et al., 2015). Current national data reveal that about 75% of adolescents whose parents reported that they received a provider recommendation initiated the HPV vaccine series, compared with 47% of adolescents whose parents reported that they had not received a recommendation (Walker et al., 2019). Parent-reported HPV vaccine recommendation differs by Census region. For example, parents who reside in the Midwest are more likely than those in other regions to report a HPV vaccine recommendation from a provider (Burdette et al., 2017). Parent-reported provider recommendation to receive the HPV vaccine also differs markedly according to race and ethnicity (Ylitalo et al., 2013). In particular, non-Hispanic white parents are more likely than non-Hispanic black and Hispanic parents to report receiving a recommendation from a health care practitioner to vaccinate their adolescents against HPV (Ylitalo et al., 2013; Polonijo and Carpiano, 2013; Jeudin et al., 2014). Provider recommendations of HPV vaccination have improved over time for adolescents and across all racial and ethnic groups (Polonijo and Carpiano, 2013). For instance, Burdette et al (Burdette et al., 2017) found that the odds of receiving a provider recommendation steadily increased by about 19% between 2008 and 2013 with a sharper increase among minority adolescents.

Because parental consent is required for HPV vaccination of

* Corresponding author at: 1200 Pressler St, Houston, TX 77030, USA.
E-mail address: CLEjezie@mdanderson.org (C.L. Ejezie).

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adolescents, parents' perception and recollection of vaccine recommendations are important (Dempsey et al., 2016). Previous research shows that the tone of provider recommendation influences parental attitudes about HPV vaccines and is associated with uptake among adolescents (Dempsey et al., 2016; Gilkey et al., 2016). For example, when parents perceive a "strong" recommendation, the likelihood of their adolescents initiating the HPV vaccine series can increase up to fivefold (Dempsey et al., 2016). Strong provider recommendation is characterized by recommendation of same-day vaccination as with other vaccines, highlighting the importance of the vaccine for cancer prevention, and emphasis on completing the vaccine series (two or three doses depending on the recipient's age) (Gilkey et al., 2016).

There is often discordance between what health care providers believe they are communicating to parents regarding HPV vaccination and what parents take away from their encounters (Dempsey et al., 2016). This discordance may be because recommendation of the HPV vaccine may include multiple communication strategies such as face-to-face discussions during routine clinic visits, electronic communication (email and text messages), and educational campaigns including wall posters and pamphlets (DiClemente et al., 2015; Bae et al., 2017; Henrikson et al., 2018; Stephens et al., 2019). Thus, whereas health care providers report recommendations provided via all of these methods, parents tend to report recommendations based on their perception and recollection (Gilkey et al., 2016). Currently, the majority of the communications between health care providers and patients in the United States are electronic (Haque, 2021; Ramirez et al., 2021; Offodile and Aloia, 2020; Balatbat et al., 2021). This strategic shift is a result of the recent structural changes in the United States health care sector necessitated by the COVID-19 pandemic (Balatbat et al., 2021; Punia et al., 2020).

Beginning in March 2020, the health care sector in the United States underwent structural changes that may have substantial implications for parent-reported provider recommendation of HPV vaccination among minority adolescents (13–17 years old) (Offodile and Aloia, 2020; Balatbat et al., 2021; Punia et al., 2020; Di Gennaro et al., 2020; Bokolo, 2020; Iancu et al., 2020; Calton et al., 2020). Specifically, most health care facilities transitioned to telemedicine, which is the use of electronic communication and software (cellphones, etc.) to provide health care services to patients without face-to-face visits (Haque, 2021; Ramirez et al., 2021; Offodile and Aloia, 2020; Balatbat et al., 2021; Punia et al., 2020; Bokolo, 2020; Iancu et al., 2020; Calton et al., 2020). Although telemedicine is available to people of all races and across the socioeconomic spectrum (Flores garcia et al., 2018; Campos-Castillo and Anthony, 2021), racial and ethnic disparities exist. Specifically, non-Hispanic black and Hispanic patients are 35% and 51% less likely to use telemedicine, respectively, than are non-Hispanic white patients (Adepoju et al., 2022). This racial disparity in telemedicine usage can be explained in part by the fundamental cause theory, which purports that the issue of health inequalities in a society is due to the uneven distribution of health care resources (Burdette et al., 2017; Polonijo and Carpiano, 2013). This theory posits that people of high socioeconomic status (SES) have better access to health care resources than do people of lower SES (Burdette et al., 2017; Williams et al., 2016; Link and Phelan, 1995; Clouston and Link, 2021). Although the fundamental cause theory was developed to study socioeconomic disparities in health, race is strongly associated with access to health care resources owing to nonequivalence of SES indicators across racial categories (Burdette et al., 2017; Williams et al., 2016; Link and Phelan, 1995). Compared with non-Hispanic white people, Hispanic and non-Hispanic black people tend to have lower income at the same educational level and are therefore, more likely to report financial hardship (Williams et al., 2016). The fundamental cause theory has been employed to examine disparities in provider recommendation of HPV vaccination (Polonijo and Carpiano, 2013; Fenton et al., 2018). For example, Polonijo and Carpiano found social disparities in provider recommendation of HPV vaccination that are consistent with the fundamental cause theory (Polonijo and Carpiano, 2013). They reported that the odds of receiving a recommendation are negatively associated with low SES and non-Hispanic black racial/ethnic status.

HPV experts believe that the COVID-19 pandemic–related structural changes in the health care sector may negatively affect the progress in parent-reported provider recommendation of HPV vaccines. Specifically, researchers predict that parent-reported provider recommendations may decline (Gilkey et al., 2020). However, the association between COVID-19–related structural changes in health care (from 2019 to 2021) and parent-reported provider recommendations of HPV vaccination among minority communities has yet to be examined. Therefore, we performed the present study to 1) describe the association between the COVID-19 pandemic and parent-reported provider recommendation of HPV vaccination among non-Hispanic black and Hispanic parents compared with non-Hispanic white parents by examining the parent-reported provider recommendation of HPV vaccination among adolescents (13–17 years old) from 2019 to 2021 and 2) investigate whether any changes in parent-reported provider recommendation of HPV vaccination from 2019 to 2021 varied by race and ethnicity. This study is significant because the findings may help researchers and policymakers improve the use of strategies such as telemedicine when recommending HPV vaccination to minority adolescents.

2. Methods

2.1. Study design and sample

In this cross-sectional study, data from the National Immunization Survey (NIS) - Teen, a yearly random-digit-dial survey of parents and caregivers of adolescents (13–17 years old) residing in the United States or its territories, collected in 2019, 2020, and 2021 were analyzed (Centers for Disease Control and Prevention, 2013). Every year, households with adolescents are identified for the survey. A parent or caregiver is interviewed by phone regarding the adolescent's vaccination history after providing verbal informed consent. Following the interview, data are reviewed to ensure completeness, and subsequently, sampling weights are calculated after adjustment for subsampling and non-response to achieve an accurate representation of the adolescent population of the United States. A subset of participants gave consent for the adolescents' vaccine providers to be contacted. Subsequently, the vaccination histories of these participants were verified by mailing requests for their medical records. Approximately 45% of adolescents with consent had adequate provider data. For this study, adolescents without adequate provider data were excluded. Also excluded were all participants who responded with "Don't know" or "Refused" regarding the question about provider recommendation of HPV vaccination and those who responded "Unknown" regarding poverty status.

Detailed information about the sampling methodology, data processing, and estimation of the survey weight is available on the NIS-Teen website (Centers for Disease Control and Prevention, 2013). Ethical review and approval of this study were waived by The University of Texas Health Science Center at Houston Committee for the Protection of Human Subjects because the NIS - Teen data are deidentified and publicly available.

2.2. Variables and measures

Parent-reported provider recommendation of HPV vaccination: The outcome variable was the report of whether a parent or caregiver ever received a recommendation from a health care professional to vaccinate their adolescent for HPV. Response options were "Yes," "No," "Don't know," and "Refused." This variable was operationalized as binary, with only "Yes" and "No" responses retained for analysis.

Race/ethnicity: The independent variable was parent-reported race/ethnicity of the adolescents. Since we were interested in comparing trends in provider recommendation across races, all the represented

racial groups were included in our sample. Race/ethnicity was categorized in the NIS-Teen dataset as non-Hispanic white, Hispanic, non-Hispanic black, and other.

Covariates: This study controlled for sociodemographic variables that have been identified in previous studies as covariates: age of the adolescent, sex of the adolescent, region, and poverty status (Reiter et al., 2021; Burdette et al., 2017). All four variables were evaluated as categorical variables. Specifically, the age of the adolescents in the study ranged from 13 to 17 years; poverty status was categorized as less than or equal to $75,000, greater than $75,000, or below poverty level; and sex was categorized as male or female. In addition, the five-digit Federal Information Processing Standard code was used to identify the region for each participant. These codes were collapsed into states in the United States and then pooled according to the four Census Bureau regions: Northeast, Midwest, South, and West (Fig. 1).

2.3. Statistical analysis

Data were pooled across years. We accounted for the complex study design and survey sampling weights used in the NIS-Teen survey. Survey respondents with missing data on provider recommendation (<2%), region (<1%), and unknown poverty status (<1%) were dropped from the analysis, resulting in a total sample of 50,739 participants. Weighted percentages were reported and therefore representative of the general population. After addressing the problem of missing data, descriptive statistics were conducted via chi-square tests for the population overall and stratified according to race/ethnicity. Following the descriptive statistical analyses, bivariate and multivariable logistic regression analyses were conducted to examine parent-reported provider recommendations from 2019 through 2021. To determine whether the changes in this period varied according to race/ethnicity, moderation analyses were conducted to see if an interaction between survey year and race/ethnicity was present. A significant effect for the interaction term ('Year X Race') would indicate that the HPV vaccine recommendations in 2019 through 2021 were inconsistent across race/ethnicity. All analyses were restricted to participants with no missing data for the outcome of interest and were done according to the analytical guidelines for the NIS-Teen data (Centers for Disease Control and Prevention, 2013). Statistical significance was defined as a two-sided P-value < 0.05 for all comparisons. All statistical analyses were conducted using Stata/IC software (version 17; StataCorp. (StataCorp, 2022).

3. Results

Of the 50,739 participants whose parents reported a provider's recommendation in the pooled sample, 51.5% were females, 20.7% were 15 years old, 54.1% were non-Hispanic White, 38.1% resided in the Southern region, 58.2% had private health insurance only, and 53.8% had a poverty status above poverty level (> $75,000) (Table 1). Of those whose parents reported not receiving a recommendation from a provider, 59.6% were male, 23.3% were 13 years old, 45.1% were non-Hispanic White, 43.9% resided in the Southern region, 46.3% had private insurance only, and 41.4% had a poverty status above poverty level (> $75,000).

After stratifying participants according to race/ethnicity, we found that about half of the parents of non-Hispanic white (50.9%), non-Hispanic black (51.5%), and Hispanic (51.1%) adolescents who reported receiving a provider's recommendation were female (Table 2). Furthermore, 20.7% of the non-Hispanic white adolescents were 15 years old, 21.3% of the non-Hispanic black adolescents were 14 years old, and 22.4% of the Hispanic adolescents were 16 years old. A majority of the non-Hispanic white adolescents (33.9%) and non-Hispanic black adolescents (59.7%) resided in the South region, whereas a majority of the Hispanic adolescents (40.2%) resided in the West region. In addition, most of the non-Hispanic white adolescents (70.9%) had private health insurance only, whereas most of the non-Hispanic black adolescents (51.3%) and a majority of the Hispanic adolescents (49.2%) had Medicaid coverage only. Most of the non-Hispanic white adolescents (65.8%) whose parents reported receiving a provider recommendation had a poverty status greater than $75,000 whereas a majority of the non-Hispanic black (40.5%) and Hispanic (37.6%) adolescents had an income (poverty status) above poverty (<= $75,000). Also, 34.1% of the parents of non-Hispanic white adolescents reported receiving a provider recommendation in 2019.

Table 3 presents findings of our moderation analysis as well as the results from our multivariable logistic regression. Our moderation analysis findings suggested that the differences in parent-reported provider recommendation of HPV vaccination from 2019 through 2021 did not vary by race/ethnicity. We re-estimated the model without the interaction term. Specifically, we conducted a multivariable logistic regression analysis to examine parent-reported provider recommendation from 2019 through 2021 and found that in the overall population, parents of female adolescents had higher odds (aOR = 1.59 [1.44, 1.75]) of receiving a provider recommendation than did parents of male adolescents. Also, parents of adolescents who were 15, 16, or 17 years old had higher odds of receiving a recommendation (aOR = 1.29 [1.12, 1.48]; aOR = 1.43 [1.23, 1.66]; aOR = 1.46 [1.24, 1.70] respectively) than did parents of adolescents who were 13 years. The odds of reporting a provider recommendation were lower for parents of Hispanic adolescents (aOR = 0.80 [0.71, 0.91]) compared to parents of non-

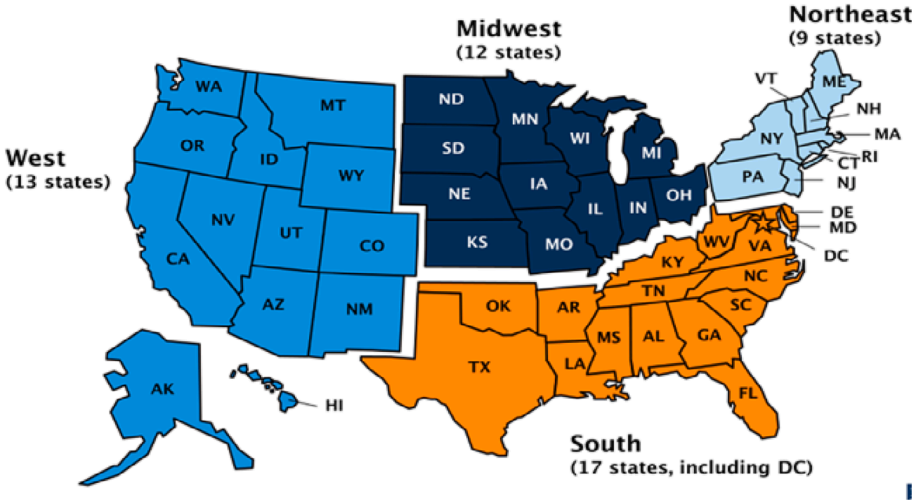

Fig. 1. Census Bureau Regions and Divisions of the United States. Source: U.S. Census Bureau.

Table 1
Descriptive statistics, overall sample, National Immunization Survey-Teen (2019–2021).

Characteristics	Overall Sample (n = 50739)			P-value
	Reported recommendation (n = 41,857) (w %)	Did not report recommendation (n = 8,882) (w%)	Total (n = 50739) (w%)	
Sex				
Male	48.5	59.6	50.7	0.00
Female	51.5	40.4	49.3	
Age, years				
13	18.8	23.3	19.7	0.00
14	20.1	22.2	20.5	
15	20.7	20.1	20.6	
16	20.5	17.8	19.9	
17	19.9	16.6	19.3	
Race/ethnicity				
Non-Hispanic white	54.1	45.1	52.3	0.00
Non-Hispanic black	13.2	15.0	13.6	
Hispanic	22.3	28.9	23.6	
Non-Hispanic other	10.4	11.0	10.5	
Region				
Northeast	16.3	12.4	15.5	0.00
Midwest	21.8	19.9	21.4	
South	38.1	43.9	39.3	
West	23.8	23.8	23.8	
Insurance status				
Any Medicaid	32.3	40.6	33.9	0.00
Other insurance	6.6	6.9	6.7	
Private insurance only	58.2	46.2	55.8	
Uninsured	2.9	6.3	3.5	
Poverty status, % of poverty line				
Above poverty <= $75,000	30.7	33.2	31.2	0.00
Above poverty > $75,000	53.9	41.4	51.4	
Below poverty	15.4	25.3	17.4	
Survey year				
2019	33.2	34.4	33.5	0.01
2020	33.7	30.4	33.0	
2021	33.1	35.1	33.5	

n = unweighted number of participants; w% = weighted percentages. P values in bold indicate statistical significance at $p \leq 0.05$. Poverty status was determined based on 2019 census poverty threshold and exact income.

Hispanic white adolescents. Parents of adolescents who resided in the West (aOR = 1.15 [0.99, 1.34]), Midwest (aOR = 1.16 [1.05, 1.29]), and Northeast (aOR = 1.38 [1.23, 1.55]) regions had higher odds of reporting a provider recommendation compared to parents who resided in the South region. Additionally, parents of adolescents who had Medicaid, private insurance, or other insurance had higher odds of receiving a recommendation (aOR = 1.94 [1.51, 2.48]; aOR = 2.07 [1.60, 2.68]; aOR = 1.83 [1.38, 2.44]) compared to those who were uninsured. The odds of receiving a provider recommendation were higher among those with a poverty status of <= $75,000 (aOR = 1.44 [1.25, 1.67]) and > $75,000 (aOR = 1.82 [1.53, 2.15]) than among those below poverty level. Our findings also demonstrated that the odds of receiving a recommendation were higher in 2020 (aOR = 1.15 [1.03, 1.29]) than in 2019.

4. Discussion

To the best of our knowledge, this study is the first to comprehensively examine parent-reported provider recommendation of HPV vaccination among minority adolescents in the United States from 2019 through 2021. Approximately one-fifth of parents of Hispanic, non-Hispanic black, and non-Hispanic white adolescents surveyed reported not receiving an HPV vaccine recommendation from a health care provider. This finding is troubling given that provider recommendation is the most important determinant of HPV vaccine uptake (Reiter et al., 2021; Rodriguez et al., 2020; Perkins et al., 2015). Our finding is consistent with results from a recent study conducted with the NIS-teen data, which demonstrated that "not recommended" was cited by most parents and caregivers as the main reason for lack of intent to vaccinate against HPV (Sonawane et al., 2020).

Overall, parent-reported provider recommendation of HPV vaccination was higher in 2020 compared to 2019 suggesting that the positive trend in recommendation rate may not have been affected by the COVID-19 pandemic. It is possible that most adolescents whose parents participated in the NIS-Teen survey may have received vaccine recommendations prior to the pandemic. Therefore, pandemic-related structural changes in health care may not have affected most adolescents. It is also possible that because COVID-19 was initially framed in 2020 as more dangerous to the elderly and immunocompromised (Bhopal et al., 2021), adolescents may have continued with their routine health care visits without interruption and their parents may have had HPV vaccine–related discussions with their providers. Another plausible hypothesis for this finding is that parents had more flexible work schedules during the pandemic than before it (Agba et al., 2020), and thus may have had more time for doctor visits during working hours in which they possibly received HPV vaccine recommendations. Also, this finding may be partly explained by the structural changes in health care that occurred during the pandemic, specifically, the transition to telemedicine (Fiks et al., 2021; Gilkey et al., 2021), which has proven to be an effective innovation. Advantages of telemedicine over traditional in-person visits are convenience and accessibility (Bokolo, 2020). Previous studies demonstrated that telemedicine can also be useful in minority communities in particular (Flores garcia et al., 2018; Campos-Castillo and Anthony, 2021; Yoost et al., 2017). The traditional face-to-face strategy entails a network of brick-and-mortar health centers, which is important for HPV vaccine conversations between parents/caregivers and health care providers. However, the trade-off has been a suboptimal rate of parent-reported HPV vaccine recommendation from providers (Burdette et al., 2017). Given the convenience and feasibility of telemedicine combined with the understanding that HPV vaccine–related conversations via this medium count as provider recommendation, it is unsurprising that a higher number of parents may be able to have HPV vaccine-related communication with their health providers, perceive the communication as a recommendation, and recall engaging in the conversation. Further research on the impact of pandemic-related structural changes in health care such as increased use of telemedicine on provider recommendation of HPV vaccination is needed.

Our finding that the interaction between race/ethnicity and survey year was not significant indicates that the COVID-19 pandemic did not trigger any race-related gaps in recommendations for HPV vaccines. This finding mirrors previous research that shows the race-related gap in parent-reported provider recommendation of HPV vaccine is closing (Burdette et al., 2017). Our finding that minority parents, specifically, Hispanic parents, had lower odds of reporting provider recommendations compared to non-Hispanic white parents also mirrors previous research (Burdette et al., 2017). Although researchers somewhat

Table 2
Descriptive statistics, respondents stratified by race/ethnicity, National Immunization Survey-Teen (2019–2021).

Characteristics	Hispanic respondents (n = 8,278)			Non-Hispanic black respondents (n = 4,186)			Non-Hispanic white respondents (n = 32,466)		
	Reported recommendation n = 6,442) (w%)	Did not report recommendation (n = 1,836) (w%)	P-value	Reported recommendation (n = 3,361) (w%)	Did not report recommendation (n = 825) (w%)	P-value	Reported recommendation (n = 27,298) (w %)	Did not report recommendation (n = 5,168) (w%)	P-value
Sex									
Male	48.9	57.8	**0.00**	48.5	58.1	**0.00**	49.1	62.4	**0.00**
Female	51.1	42.2		51.5	41.9		50.9	37.6	
Age, years									
13	18.4	24.6	**0.00**	19.3	22.3	0.30	18.7	23.3	**0.00**
14	19.4	22.6		21.3	23.3		19.8	21.4	
15	20.7	21.1		21.3	22.8		20.5	19.9	
16	22.3	17.9		18.4	16.0		20.4	17.8	
17	19.2	13.8		19.7	15.6		20.6	17.6	
Region									
Northeast	12.6	10.2	0.12	14.7	11.2	0.20	18.3	13.5	**0.00**
Midwest	10.3	11.3		17.6	17.1		28.3	26.9	
South	36.9	41.6		59.7	65.8		34.0	40.0	
West	40.2	36.9		8.0	5.9		19.4	19.6	
Insurance status									
Any Medicaid	49.2	54.2	**0.00**	51.3	51.6	0.43	21.2	28.2	**0.00**
Other insurance	6.7	5.8		5.8	6.4		6.2	7.8	
Private insurance only	38.1	28.0		40.2	37.6		70.8	60.0	
Uninsured	6.0	12.0		2.7	4.4		1.8	4.0	
Poverty status, % of poverty line									
Above poverty <= $75000	37.6	32.8	**0.00**	40.5	37.5	0.16	26.2	33.4	**0.00**
Above poverty > $75,000	34.7	23.9		33.5	31.1		65.8	54.0	
Below poverty	27.7	43.3		26.0	31.4		7.9	12.6	
Survey year									
2019	32.3	33.9	0.69	34.6	33.5	0.72	34.1	35.8	0.11
2020	33.6	31.3		32.5	31.3		33.7	31.0	
2021	34.1	34.7		32.9	35.2		32.2	33.2	

n = unweighted number of participants; w% = weighted percentages. Bolded p values indicate statistical significance at $p \leq 0.05$. Poverty status was determined based on 2019 census poverty threshold and exact income.

observed this trend prior to the pandemic (Perkins et al., 2015; Burdette et al., 2017), we postulate that the pandemic may have contributed to the racial differences in parent-reported provider recommendation of HPV vaccination. Plausible pandemic-related reasons include barriers associated with the use of telemedicine in minority communities including limited access to technological devices and low level of comfort with technology (Graves et al., 2021). These barriers may reduce opportunities for providers to discuss HPV vaccines with minority patients, which may have a negative impact on HPV vaccination in the long run. Our findings also suggest that health care providers in minority communities may have been focused on getting the COVID-19 pandemic under control (Gilkey et al., 2020). Because people in minority communities were most affected by the pandemic (Alcendor, 2020; Peek et al., 2021; Tai et al., 2021; Burger et al., 2021), prioritization of controlling it over other public health efforts, including provider recommendation of HPV vaccination, is not surprising. While we looked at provider recommendation of HPV vaccination, we did not examine how that recommendation translated into vaccination initiation.

In our Census region analysis, we found that in the South, parents had lower odds of reporting a recommendation compared to parents in the other regions. This finding has important public health implications. The South region has the lowest reported HPV vaccination completion rates in the United States (e.g., Mississippi's completion rate is 28.8% [Hirth, 2019], compared with the national rate of 57.1 % [Ejezie et al., 2022]). Continued low parent-reported provider recommendation rates may exacerbate the persistently low HPV vaccine uptake in this region. As a result, the South region may face a disproportionately higher burden of HPV-related cancers in future decades than regions with higher parent-reported provider recommendation rates.

Our study has some limitations. Consistent with most studies in this area, we relied on parental reporting of provider recommendation of HPV vaccination, which may be subject to recall bias. Also possible is inclusion bias, as we included only people with adequate provider data, so we may have excluded participants without health insurance. The survey question used to examine parent-reported provider recommendation ("Has a doctor or other health care professional ever recommended that [teen name] receive HPV shots?") is not time bound. Therefore, the survey may include recommendations made in previous years and could potentially diminish differences in vaccine recommendation in 2019, 2020 and 2021. However, this question is useful in

Table 3
Association between sociodemographic characteristics and provider recommendation among 13–17-year-olds in overall sample, National Immunization Survey-Teen (2019–2021).

Characteristics	Crude OR (95% CI)	Adjusted OR (95% CI)[a]	Adjusted OR (95% CI)[b]
Overall (n = 50,739)			
Sex			
Male	Ref	Ref	Ref
Female	**1.56 (1.42–1.72**	**1.59 (1.44–1.75)**	**1.59 (1.44–1.75)**
Age, years			
13	Ref	Ref	Ref
14	1.12 (0.98–1.29)	1.13 (0.98–1.30)	1.13 (0.98–1.30)
15	**1.27 (1.11–1.46)**	**1.28 (1.12–1.48)**	**1.29 (1.12–1.48)**
16	**1.43 (1.23–1.66)**	**1.43 (1.23–1.66)**	**1.43 (1.23–1.66)**
17	**1.48 (1.27–1.73**	**1.45 (1.24–1.70)**	**1.46 (1.24–1.70)**
Race/ethnicity			
Non-Hispanic white	Ref	Ref	Ref
Non-Hispanic black	**0.73 (0.64–0.84)**	1.01 (0.78–1.30)	0.90 (0.78–1.05)
Hispanic	**0.64 (0.56–0.72)**	0.81 (0.66–1.01)	**0.80 (0.71–0.91)**
Non-Hispanic other	**0.78 (0.66–0.92)**	0.79 (0.58–1.07)	**0.81 (0.69–0.97)**
Region			
South	Ref	Ref	Ref
West	1.15 (0.99–1.33)	**1.15 (0.99–1.34)**	**1.15 (0.99–1.34)**
Midwest	**1.26 (1.14–1.39)**	**1.16 (1.05–1.29)**	**1.16 (1.05–1.29)**
Northeast	**1.50 (1.34–1.68)**	**1.38 (1.23–1.55)**	**1.38 (1.23–1.55)**
Insurance status			
Uninsured	Ref	Ref	Ref
Any Medicaid	**1.77 (1.39–2.24)**	**1.93 (1.51–2.48)**	**1.94 (1.51–2.48)**
Private insurance only	**2.79 (2.21–3.53)**	**2.07 (1.59–2.68)**	**2.07 (1.60–2.68)**
Other insurance	**2.14 (1.63–2.81)**	**1.84 (1.38–2.45)**	**1.83 (1.38–2.44)**
Poverty status, % of poverty line			
Below poverty	Ref	Ref	Ref
Above poverty <= $75,000	**1.51 (1.32–1.73)**	**1.44 (1.25–1.66)**	**1.44 (1.25–1.67)**
Above poverty > $75,000	**2.13 (1.87–2.43)**	**1.81 (1.53–2.15)**	**1.82 (1.53–2.15)**
Survey year			
2019	Ref	Ref	Ref
2020	**1.14 (1.02–1.28)**	**1.15 (1.01–1.31)**	**1.15 (1.03–1.29)**
2021	0.97 (0.86–1.09)	1.01 (0.88–1.16)	0.96 (0.85–1.08)
Interaction between year and race			
Non-Hispanic white X 2020		Ref	
Non-Hispanic black X 2020		0.85 (0.61–1.20)	
Hispanic X 2020		0.98 (0.73–1.32)	
Non-Hispanic other X 2020		1.37 (0.94–2.00)	
Non-Hispanic black X 2021		0.85 (0.60–1.22)	
Hispanic X 2021		0.97 (0.71–1.33)	
Non- Hispanic other X 2021		0.84 (0.63–1.11)	

Bolded values indicate statistical significance at $p \leq 0.05$; OR = odds ratio; CI = confidence interval; Ref = reference category.

[a] *Model estimated with interaction term and adjusted for sociodemographic characteristics and survey year.*

[b] *Model re-estimated without interaction term and adjusted for sociodemographic characteristics and survey year. Poverty status was determined based on 2019 census poverty threshold and exact income.*

examining if parent-reported provider recommendation of HPV vaccination has improved over time and thus, is applicable to our research in examining whether the COVID-19–related structural changes in health care affected the progress in these recommendations. Several studies have employed this question from the NIS-Teen survey to study trends in provider recommendation of HPV vaccination (Perkins et al., 2015; Burdette et al., 2017). Another limitation is that previous HPV vaccination may decrease the likelihood of providers recommending it. The NIS-teen dataset does not contain information regarding the quality of recommendation of HPV vaccination. Specifically, we were unable to ascertain if parents/caregivers received a strong or weak recommendation. High quality recommendation is associated with ninefold higher odds of HPV vaccine initiation (74% vs. 23%, OR = 9.31, 95% CI, 7.10–12.22) and more than three times the odds of follow-through (44% vs. 17%, OR = 3.82, 95% CI, 2.39–6.11) compared to low-quality recommendation (Gilkey et al., 2016). The 2020 and 2021 NIS-Teen data can be used to assess the impact of the COVID-19 pandemic on the progress in parent-reported provider recommendation of HPV vaccination for adolescents aged 13 to 17 years (which is the goal of our present research) but not on parent-reported provider recommendation according to the Advisory Committee on Immunization Practices (ACIP) vaccination schedule (that recommends that children who are 11 to 12 years old receive the HPV vaccine) (Pingali et al., 2021). This is because adolescents included in the survey were at least 13 years old, which is past the age when most routine adolescent vaccines are recommended. Since recommendation of HPV vaccination starts at the age of 9 years, there is a need for vaccine registries to provide de-identified data of vaccination records for adolescents younger than 13 years to enable HPV vaccine researchers to better examine parent-reported provider recommendation and HPV vaccine uptake according to the ACIP recommended vaccination schedule. Strengths of the study include its large sample size and nationally representative data.

The present study contributes to previous research in that we examined racial disparities in parent-reported provider recommendations of HPV vaccine uptake. We showed that despite the COVID-19 pandemic, which disproportionately affected minority communities, racial disparities in parent-reported provider recommendation of HPV vaccination are narrowing. This important gain may be associated with the structural changes in health care that occurred during the pandemic. Since most health care providers are advocating continued use of telemedicine even after the pandemic (Di Gennaro et al., 2020; Bokolo, 2020; Iancu et al., 2020), findings from this research may be important for ongoing improvement in telemedicine-based provider recommendation of HPV vaccination.

5. Conclusion

Provider recommendation of HPV vaccination is strongly associated

with HPV vaccine uptake among adolescents, yet parent-reported provider recommendation for it among minority adolescents remains suboptimal. Despite the COVID-19 pandemic, parents reported receiving a recommendation more often in 2020 than 2019. While this is an important gain, more effort is needed to improve parent and provider communication regarding HPV vaccination of adolescents.

6. Financial disclosure

None reported.

7. Ethics approval

Ethical review and approval for this study was waived by the University of Texas Health Science Center at Houston Committee for the Protection of Human Subjects because the NIS-Teen data is de-identified and publicly available.

8. Consent to participate

Informed consent was obtained from all individual participants included in the study.

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Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Chinenye Lynette Ejezie. The first draft of the manuscript was written by Chinenye Lynette Ejezie and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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