



Association of caregiver attitudes with adolescent HPV vaccination in 13 southern US states



Lavanya Vasudevan^{a,b,c,*}, Jan Ostermann^{b,d,e}, Yunfei Wang^c, Sayward E. Harrison^{e,f}, Valerie Yelverton^d, Laura J. Fish^{a,g}, Charnetta Williams^h, Emmanuel B. Walter^{b,c,i}

^a Department of Family Medicine and Community Health, Duke University School of Medicine, 2200 W. Main Street, Suite 600, Durham, NC 27705, USA

^b Duke Global Health Institute, 310 Trent Drive, Durham, NC 27710, USA

^c Duke Human Vaccine Institute, 27 Alexandria Way, Durham, NC 27703, USA

^d Department of Health Services Policy & Management, University of South Carolina, 915 Greene Street, Columbia, SC 29208, USA

^e South Carolina Smart State Center for Healthcare Quality, Arnold School of Public Health, University of South Carolina, 915 Greene Street, Columbia, SC 29208, USA

^f Department of Psychology, University of South Carolina, 1512 Pendleton Street, Barnwell College, Suite #220, Columbia, SC 29208, USA

^g Duke Cancer Institute, 2424 Erwin Rd, Suite 602, Durham, NC 27710, USA

^h Immunization Services Division, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA 30329, USA

ⁱ Department of Pediatrics, Duke University School of Medicine, Box 3675, DUMC, Durham, NC 27710, USA

ARTICLE INFO

Article history:

Received 10 February 2022

Received in revised form 20 May 2022

Accepted 23 May 2022

Available online 15 June 2022

Keywords:

Human Papillomavirus

Immunization

Adolescents

Southern United States

Caregiver attitudes

ABSTRACT

Background and objectives: HPV vaccination coverage is lower than that of other adolescent vaccines in the southern US. This study sought to characterize caregiver attitudes associated with adolescent HPV vaccination in the southern US and to inform interventions to promote HPV vaccination.

Methods: From December 2019 – January 2020, caregivers of adolescents (ages 9–17 years) living in thirteen southern US states were recruited from a nationally-representative online survey panel. Caregivers (N = 1,105) completed a cross-sectional survey that assessed general adolescent vaccine attitudes as well as those associated with the HPV vaccine and HPV vaccination decision-making. The primary study outcome was adolescents' receipt of at least one dose of the HPV vaccine.

Results: Caregivers with vaccinated adolescents had greater positive attitudes towards adolescent vaccines compared to caregivers of unvaccinated adolescents. Top three areas of concern among caregivers were related to vaccine ingredients, perceptions that adolescents receive too many vaccines, and worry about vaccine side effects. In multivariable regression models, positive attitudes towards the HPV vaccine and HPV vaccination decision-making strongly associated with HPV vaccination in addition to general adolescent vaccination attitudes. Caregivers' reported discomfort with discussing the topic of sex was predictive of lower vaccination uptake for older adolescents.

Conclusions: Public health messaging in the southern US should be tailored to reduce concerns about vaccine safety and to communicate the importance of timely HPV vaccination. Campaigns that deliver information specific to the HPV vaccine and to support vaccination decision-making may be more effective than those delivering only general adolescent vaccination information at promoting on-time HPV vaccination.

© 2022 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Despite the effectiveness of the Human Papillomavirus (HPV) vaccine as a cancer-prevention strategy, only 1 in 2 adolescents in the United States (US) is up-to-date with vaccination [1,2]. While HPV vaccination coverage is increasing steadily in the US,

current numbers fall short of the Healthy People goal of 80% up-to-date coverage by 2030 [2,3]. Recent studies suggest that parental attitudes rather than vaccine access is a key driver of HPV vaccine uptake among adolescents [2,4]. Nationally, HPV vaccination coverage lags behind the coverage of other adolescent vaccinations suggesting that HPV-specific attitudes may influence uptake [2,5,6].

Negative parental attitudes towards vaccines are a well-known contributor to vaccine hesitancy – the decision to intentionally

* Corresponding author at: 2200 W. Main Street, Suite 600, Durham, NC 27710, USA.

E-mail address: lavanya.vasudevan@duke.edu (L. Vasudevan).

delay or refuse vaccinations [7]. A recent study assessing trends in NIS-Teen data identified negative parental attitudes and a lack of knowledge about HPV vaccine recommendations as the primary reasons for non-vaccination of adolescents [8]. Examples of negative parental attitudes include concerns about HPV vaccine safety and side effects, backlash against HPV vaccine mandates, religious objections to vaccination, belief that HPV vaccination promotes sexual promiscuity in vaccinated adolescents, and low perceived risk of HPV infection or HPV-related cancers [4,8–11]. The presence of vaccine concerns can be worsened by the exposure to misinformation and false vaccine controversy [12,13]. Hence, the proactive identification and mitigation of negative parental attitudes is critical for closing the gaps in HPV vaccination coverage among adolescents [14].

Southern US Health and Human Services (HHS) regions 4 and 6 have a high burden of HPV-attributable cancers but some of the lowest up-to-date adolescent HPV vaccination coverage rates in the country (50.3% and 49.6%, respectively) [15]. In a recent study of vaccine hesitancy across the US, Santibanez et al reported some of the highest prevalence of vaccine hesitancy (>15%) among parents residing in the southern US [16]. Although that study examined parental vaccine hesitancy in the context of the influenza vaccine, the trends are concerning in light of the low HPV vaccination coverage among adolescents in the southern US. Contextualizing drivers of negative parental attitudes toward HPV vaccination in the southern US could yield important insights to guide public health messaging in the region and to improve adolescent vaccine uptake [17].

Several validated and widely used measures of parental attitudes towards adolescent vaccines, including the HPV vaccine, have been described in the literature [18–26]. Limitations of existing measures include their focus on specific sub-populations such as immigrant families, male [24] or female [21] adolescents, or those of Hispanic ethnicity, assessment of general adolescent vaccine beliefs [18,20,22], and lack of up-to-date safety and efficacy estimates for the HPV vaccine or guidelines for HPV vaccination [19,25]. Since HPV vaccine-specific attitudes may be driving parental decisions, there is a need to review and adapt existing measures to reflect up-to-date guidelines and evidence on HPV vaccination and targeted to parents in general.

As part of a larger study on HPV vaccination disparities in the southern US, we conducted a cross-sectional survey to characterize caregiver attitudes and their associations with adolescent HPV vaccination. Attitudes were assessed using items from the existing literature on HPV vaccine attitudes, adapted to appeal to the general population and updated to reflect the most recent guidelines and data on HPV vaccination. The adapted items assessed a range of caregiver attitudes, including general attitudes towards adolescent vaccines, and attitudes specifically associated with the HPV vaccine, and HPV vaccination decision-making.

Methods

The detailed methods of this study have been reported previously in accordance with the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) statement for cross-sectional studies and presented in **Supplementary Table 1** [5,27]. Key information relevant to the analyses are described below.

Study design and setting

From December 2019 – January 2020, caregivers (parents and legal guardians) of adolescents (ages 9–17 years) were recruited from 13 southern states through a nationally-representative online

survey panel [28]. Panel members self-administered the study survey online using the QualtricsSM survey platform.

Ethical approval

The study protocol was approved by the Duke University Health System (DUHS) Institutional Review Board (Pro00101137) and the University of South Carolina Institutional Review Board (Authorization agreement for reliance on DUHS IRB; Pro00085811). Since the Centers for Disease Control and Prevention (CDC) only had access to de-identified data, it was determined that the CDC was not engaged in human subjects research and CDC's IRB approval was not required.

Participants and recruitment

To be eligible to take the survey, panel members had to be at least 18 years of age, reside in one of 13 states in the southern US (Department of Health and Human Services, HHS, regions 4 and 6; Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas), and be a parent or legal guardian (henceforth “caregiver”) of an adolescent between 9 and 17 years of age. The survey was only available in English. Panel members received a link to the survey via email, and recruitment continued until the sample size target was reached.

Sample size and justification

Due to the exploratory nature of the survey, the target sample size was derived from a purposive sample estimate of 1,000 caregivers meeting eligibility criteria who were available in the survey panel in the 13 states as well as the anticipated survey response rates.

Data sources/measurement

When responding to the survey questions, caregivers were asked to refer to their child who was between the ages of 9–17 years at the time of the survey (henceforth “adolescent”) and who had the most recent birthday at the time of the survey. Demographic data of caregivers and survey weights to ensure representativeness of the target population were provided by the online survey panel company. All other data presented in this analysis reflect self-reported responses of caregivers from the survey. The survey included questions about caregivers' and adolescents' socio-demographic characteristics, adolescents' vaccination status, and caregivers' attitudes towards adolescent vaccines in general, HPV infection, the HPV vaccine, and HPV vaccination decision-making. The primary outcome was the receipt of ≥ 1 dose of the HPV vaccine. HPV vaccination intention was assessed for caregivers of unvaccinated adolescents as well as those who did not complete all HPV vaccine doses. Details of caregiver and adolescent characteristics and HPV vaccination intention are published elsewhere [5].

The study team reviewed existing measures of caregiver attitudes [18–26] and grouped assessment items (henceforth referred to as ‘items’) in three categories: general adolescent vaccination attitudes, HPV vaccine-specific attitudes, and attitudes related to HPV vaccination decision-making (see **Box 1**). Items were reviewed for relevance to ensure that they reflected the most recent evidence and adolescent vaccination guidelines in the US at the time the survey was fielded. For instance, items about the newness of the HPV vaccine [19] or an exclusive focus on the vaccine recommendation for girls [19] were considered not relevant. The wording of each item was also reviewed to ensure relevance to the general US population (i.e., when the original item focused on a specific subpopulation), and edited for brevity, clarity, and consistency

Box 1: Survey assessment items on caregiver attitudes. General adolescent vaccination attitudes (9 items, 0-strongly disagree to 10-strongly agree)

Vaccines are necessary to protect the health of adolescents.

Vaccines do a good job in preventing the disease they are intended to prevent.

Vaccines are safe.

If I do not vaccinate my adolescent, he/she may get a disease and cause other adolescents or adults also to get the disease.

Adolescents receive too many vaccines.^a

If I vaccinate my adolescent, he/she may have serious side effects.^a

In general, medical professionals in charge of vaccinations have my adolescent's best interest at heart.

I have a good relationship with my adolescent's health care provider.

I worry about the ingredients in vaccines.^a

HPV vaccine-specific attitudes (7 items, 1-strongly agree to 5-strongly disagree)

The HPV vaccine is not very effective.

The HPV vaccine may lead to long-term health problems.^b

The HPV vaccine is being pushed to make money for pharmaceutical companies.

There has not been enough research done on the HPV vaccine.

The HPV vaccine is/may be too painful for my child.^b

HPV vaccine is harmful.^b

The dangers of HPV vaccine are being covered up by the government and pharmaceutical companies.^b

HPV vaccination decision-making attitudes (8 items, 1-strongly agree to 5-strongly disagree)

The HPV infection is not severe enough to warrant vaccination.

Children are getting the HPV vaccine too early.^{b, c}

Vaccinating my adolescent against HPV is a good thing to do for their health.^b

People who are important to me support vaccinating my adolescent against HPV.^b

My adolescent's health care provider thinks that I should vaccinate my adolescent against HPV.^b

I feel I have enough knowledge to make an informed decision about my adolescent's HPV vaccination.^b

I am OK with my adolescent getting the HPV vaccine without my consent.

HPV vaccination should be required by my adolescent's school.

Footnotes: HPV: Human Papillomavirus. ^aItems were reverse coded such that higher scores reflect positive attitudes. ^bItem wording updated from original to reflect up-to-date guidelines on HPV vaccination for adolescents, improve clarity, brevity or comprehension. ^cItems were reverse coded such as lower scores reflect negative attitudes.

with other items (see Box 1). Likert scales for responses were chosen to match the original validated measures when possible or restricted to 5 points for brevity and to reduce burden on survey takers.

General adolescent vaccination attitudes. A total of nine items were included in this measure, eight of which were included as is from a previously validated measure of general caregiver attitudes towards adolescent vaccines [29]. These eight original items covered caregiver attitudes about the need for adolescent vaccines, vaccine effectiveness and safety, individual and community risk

of vaccine-preventable diseases, number of recommended vaccines, risk of side effects, and trust in healthcare providers. The Likert response scale for this measure ranged from 0 (strongly disagree) to 10 (strongly agree) to match the original validated measure. Two items ("Adolescents receive too many vaccines" and "If I vaccinate my adolescent, he/she may have serious side effects") were phrased negatively compared with other items in the measure. These negatively worded items were reverse coded to match other items such that higher scores reflected more positive attitudes. To reflect caregiver concerns about vaccine ingredients [30], a ninth item "I worry about the ingredients in vaccines" was added to the measure by the study team. This item was negatively worded, and hence, also reverse scored such that higher scores reflected more positive attitudes towards adolescent vaccines.

HPV vaccine-specific attitudes. Since HPV vaccination coverage rates lag those of other adolescent vaccinations, the team decided to include items that captured concerns or negative attitudes that were specifically associated with the HPV vaccine. These items were adapted from published measures and edited as previously described (see Box 1). Items focused on perceptions of vaccine effectiveness, immediate, long-term, and non-specific risks, adequacy of research, conflicts of interest, and conspiracy beliefs. The responses to these items were captured using a 5-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). Since all items were negatively worded, greater disagreement with items (i.e., higher scores) indicated more positive attitudes towards the HPV vaccine.

Attitudes related to HPV vaccination decision-making. To capture caregiver attitudes that were related to HPV vaccination decision-making, the team compiled 8 items related to the perceived severity of HPV infection, acceptability with age of vaccine recommendation, vaccination as norm, social support for the vaccination decision, provider recommendation for the vaccine, knowledge sufficiency, consent for vaccination and acceptability of school mandates. The responses to these items were captured using a 5-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). One item was reverse scored (see Box 1) such that lower scores indicated more positive attitudes. In the final analysis, a reverse combined mean score was generated to match the other two measures where higher scores indicate more positive attitudes.

Survey weights and external validity

Geo-demographically calibrated weights were provided by the online survey panel company [31] and applied to the data to correct for any sampling biases and to ensure the representativeness of the survey findings to the target population, households with adolescents ages 9–17 years in the southern US.

Statistical methods

Survey data were analyzed using SAS 9.4 (SAS Institute, Cary, NC) with bivariable and multivariable survey-analytic regression methods. Receipt of ≥ 1 dose of the HPV vaccine ("yes" vs. "no") was the primary dependent variable.

For each of the three caregiver attitude measures, the distribution of response options by item was computed and plotted to illustrate any differences among the vaccinated and unvaccinated groups. In addition, a mean score and standard deviation was calculated for each item individually and a combined mean score was generated for each measure for comparing caregiver attitudes in the vaccinated and unvaccinated groups. Where relevant, items were reverse scored prior to the calculation of the combined mean score (see Box 1). Parametric (χ^2) tests were used to compare weighted differences between the vaccinated and unvaccinated

Table 1
 Characteristics of caregivers (n = 987) from 13 southern states in the United States stratified by the HPV vaccination status of their adolescents.

Covariate	Level	Has your adolescent ever received the HPV vaccine?		Parametric P-value ^a
		Yes N = 368	No/Other N = 619	
Age (mean(SD))		44.03 (±7.61)	41.65 (±7.71)	<0.001
Gender (n (%))	Male	140 (37.9)	255 (41.1)	0.32
	Female	228 (62.1)	365 (58.9)	
Residence ^b (n (%))	Urban	308 (83.7)	486 (78.5)	0.05
	Rural	60 (16.3)	133 (21.5)	
Education (n (%))	Bachelor's degree or higher	125 (33.9)	202 (32.7)	0.70
	Less than Bachelor's degree	243 (66.1)	417 (67.3)	
Currently working (n (%))	Yes	284 (77.3)	508 (82.1)	0.07
	No/Don't know	83 (22.7)	111 (17.9)	
Has anyone you know ever had any of the following (n (%))	HPV infection	88 (24)	104 (16.8)	0.006
	HPV-related morbidity/cancers ^c	164 (44.6)	213 (34.4)	0.001
	Other cancers	148 (40.2)	215 (34.7)	0.09
	Other STIs	97 (26.2)	140 (22.5)	0.19
	None of the above	103 (27.9)	184 (29.7)	0.54
	Don't know	23 (6.3)	54 (8.8)	0.17
I am uncomfortable talking with my child about sex (mean(SD))	Scale of 0-10 ^d	2.95 ± (3.22)	3.62 (±3.2)	0.002
My child is not sexually active (mean(SD))	Scale of 0-10 ^d	7.95 (±3.14)	8.77 (±2.41)	<0.001

Abbreviations: HPV, Human Papillomavirus. SD, Standard deviation. **Footnotes:** Number of observations may not add up to 987 due to missing values on HPV vaccination status or other variable of interest. n(%) reported unless otherwise noted. ^aThe parametric p-value is calculated by chi-square test. ^bRural-urban residence status was assigned based on Census definition: <https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html>. For 66 records with zip codes in non-residential areas, rural-urban designation was based on the USDA FIPS code: <https://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx>. ^cCombines response options for abnormal PAP smear, cervical cancer/pre-cancer, anal cancer, and head/neck cancer. ^dScale of 0-10 where 0 indicates highest disagreement with item. Lower scores indicate positive attitudes.

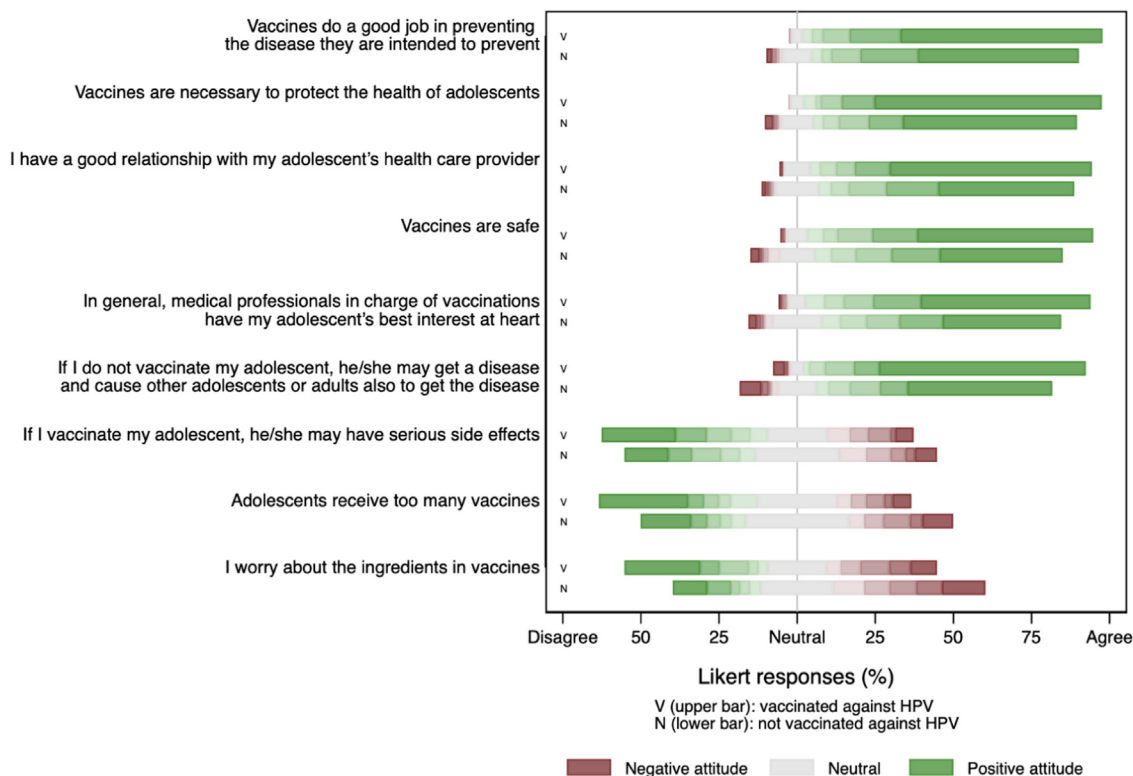


Fig. 1. Caregivers' general attitudes towards adolescent vaccines, stratified by their adolescents' HPV vaccination status. The Likert responses were on a scale of 0-10, where 0-strongly disagree to 10-strongly agree.

groups. Cronbach's alpha was computed for each item and for the combined item score for each measure to assess the internal consistency. An alpha value of 0.7 or greater was considered acceptable.

Weighted multivariable logistic regression models were used to assess correlations between adolescents' HPV vaccination status and caregiver attitudes. Combined mean attitude scores for the three measures (general adolescent vaccination attitudes, HPV

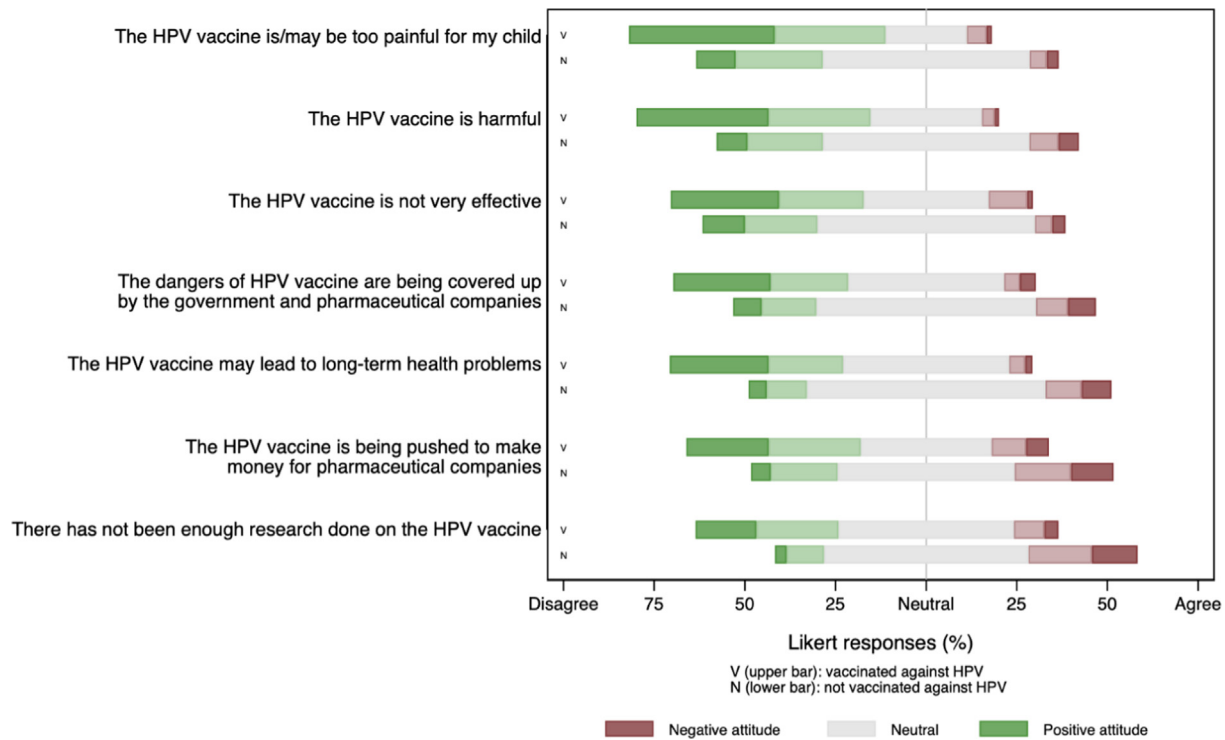


Fig. 2. Caregivers' attitudes toward the HPV vaccine, stratified by their adolescents' HPV vaccination status. The Likert responses were on a scale of 1–5, where 1-strongly agree to 5-strongly disagree.

vaccine-specific attitudes and attitudes related to adolescent HPV vaccination decision-making) were used as covariates. For all measures, higher mean scores represent positive caregiver attitudes. Models controlled for key covariates that differed between the vaccinated and unvaccinated groups. Details of these covariates have been previously published and include adolescent age, gender, school type, caregivers' employment status, travel time to usual healthcare provider, and provider recommendation for the HPV vaccine [5]. Odds ratios and 95% confidence intervals were computed to describe the extent to which differences in vaccination rates were associated with systematic variation in covariates; p-values < 0.05 were considered statistically significant. Missing values were excluded from the analysis.

We used weighted generalized linear mixed models to examine associations between socio-demographic characteristics and outcome variables of attitudes. Error correlation within states were accounted by clustering data at the state level. The extent to which differences in caregivers' attitudes were associated with variation in predictor variables are described in estimates and standard errors.

Results

The survey response rate was 55.2%; data from 987 caregivers were included in the final analysis after excluding incomplete responses and those from participants who did not meet inclusion criteria.

Table 1 shows characteristics of caregivers stratified by the HPV vaccination status of their adolescent. Approximately one in three (37.3%; n = 368) caregivers reported that their adolescent had received at least one dose of the HPV vaccine. Compared with caregivers of unvaccinated adolescents, more caregivers of vaccinated adolescents were older on average, lived in an urban area, and knew someone with HPV infection, morbidity, or cancer. More

caregivers of unvaccinated adolescents reported that they were uncomfortable talking with their adolescent about sex and that their adolescent was not sexually active.

Fig. 1 and Supplementary table 2 show the responses to nine items assessing caregivers' general adolescent vaccination attitudes, with responses stratified by their adolescents' HPV vaccination status. On a scale of 0–10, where higher scores indicated more positive attitudes, caregivers of vaccinated adolescents had a higher mean combined score (7.98 ± 1.53) compared with caregivers of unvaccinated adolescents (7.08 ± 1.97). More caregivers of unvaccinated adolescents had concerns related to vaccine ingredients, the number of recommended vaccines, and vaccine side effects. The items included in the general adolescent vaccination attitude measure showed high internal consistency (see: supplementary table 2; Cronbach's alpha = 0.87), hence the combined mean score was used in multivariable analyses.

Fig. 2 and Supplementary table 3 show caregivers' attitudes towards the HPV vaccine, with responses stratified by their adolescents' HPV vaccination status. On a scale of 1–5, where higher scores reflected more positive attitudes, caregivers of vaccinated adolescents reported a higher mean combined score (3.65 ± 0.8) compared with caregivers of unvaccinated adolescents (3.01 ± 0.75). Greatest concerns among caregivers of unvaccinated adolescents were related to the perceived inadequacy of research on the HPV vaccine, perception that the HPV vaccine is not very effective, and the notion that the HPV vaccine was pushed to profit pharmaceutical companies. The seven items included in this measure showed high internal consistency (see: supplementary table 3; Cronbach's alpha = 0.89), hence the combined mean score was used in multivariable analysis.

Fig. 3 and Supplementary table 4 show caregivers' attitudes related to HPV vaccination decision-making, with responses stratified by their adolescents' HPV vaccination status. On a scale of 1–5, lower scores represent positive attitudes. More caregivers of vaccinated adolescents reported perceived severity of HPV infection,

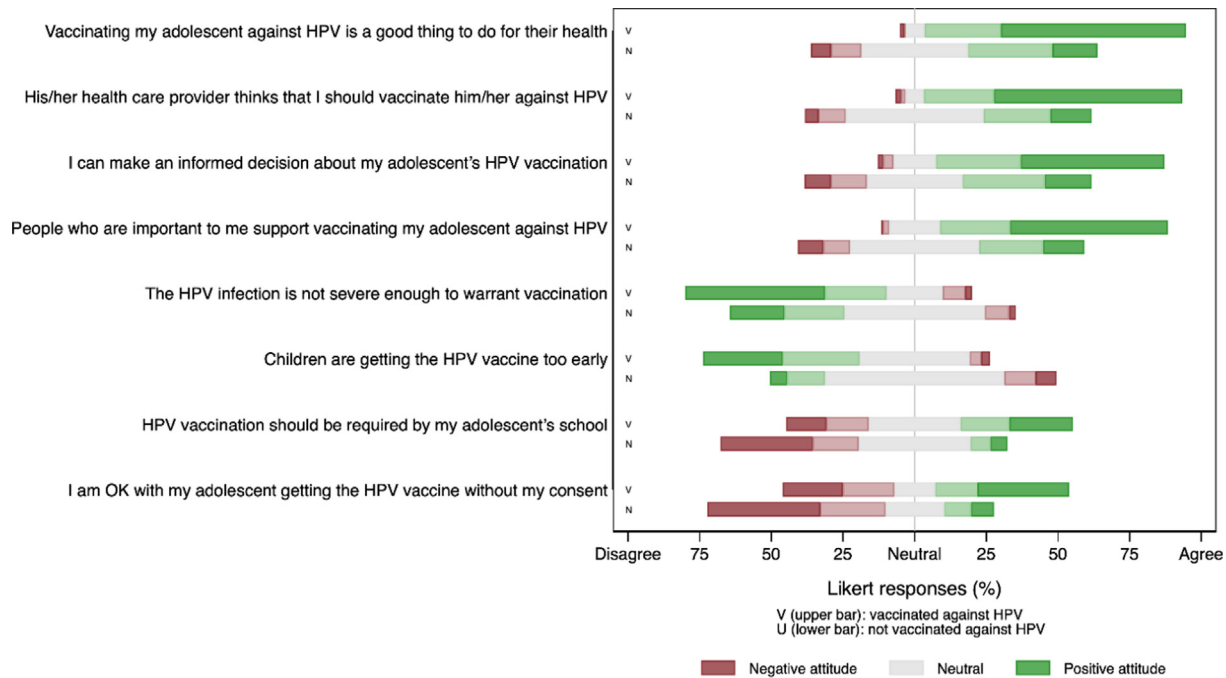


Fig. 3. Caregivers' attitudes related to HPV vaccination decision-making, stratified by adolescents' HPV vaccination status. The Likert responses were on a scale of 1–5, where 1-strongly agree to 5-strongly disagree.

Table 2

Association of caregivers' attitudes and HPV vaccination among adolescents aged 9–17 years (N = 987) from 13 southern states in the United States.

Variables ^a	OR (95% CI) Unadjusted	p-value	aOR ^{b,c} (95% CI)	p-value
General vaccine attitudes score	1.34 (1.15,1.57)	<0.001	1.43 (1.2,1.71)	<0.001
HPV vaccine attitudes score	2.96 (1.93,4.54)	<0.001	3.26 (2.32,4.59)	<0.001
HPV vaccination attitudes score ^d	5.65 (3.84,8.29)	<0.001	4.82 (2.82,8.23)	<0.001
My child is unlikely to get an HPV-related disease.	0.89 (0.82,0.96)	0.003	0.93 (0.85,1.02)	0.10
I am uncomfortable talking with my child about sex.	0.94 (0.89,0.99)	0.02	0.94 (0.89,0.99)	0.02
My child is not sexually active.	0.9 (0.86,0.94)	<0.001	0.96 (0.89,1.03)	0.25

Abbreviations: HPV; Human Papillomavirus. **Footnotes:** ^aCombined mean score for each scale used in the regression model. ^bModel adjusts for the following previously known socio-demographic and healthcare access covariates: adolescent's ethnicity/race, adolescent's gender, adolescent's age, adolescent's school type, caregivers' working status, travel time to usual health care provider and provider recommendation for HPV vaccine. ^cChange in odds of vaccination for every 1 point increase in attitude score. ^dReversed combined mean score used in the model such that higher score indicates positive attitudes.

Table 3

Association of caregiver attitudes and HPV vaccination among adolescents aged 9–10 years (N = 225, 22.8%) from 13 southern states in the United States.

Variables ^a	OR (95% CI) unadjusted	p-value	aOR ^{b,c} (95% CI)	p-value
General vaccine attitudes score	1.11(0.65,1.91)	0.70	4.33(1.45,12.98)	0.009
HPV vaccine attitudes score	2.47(1.05,5.83)	0.04	1.58(0.66,3.81)	0.30
HPV vaccination attitudes score ^d	1.36(0.47,3.91)	0.57	3.93(0.36,43.35)	0.26
My child is unlikely to get an HPV-related disease.	1.23(0.93,1.63)	0.15	1.35(0.98,1.85)	0.07
I am uncomfortable talking with my child about sex.	0.73(0.46,1.16)	0.18	0.9(0.58,1.38)	0.63
My child is not sexually active.	0.8(0.65,0.98)	0.03	0.68(0.46,1)	0.05

Abbreviations: HPV; Human Papillomavirus. **Footnotes:** ^aCombined mean score for each scale used in the regression model. ^bModel adjusts for the following previously known socio-demographic and healthcare access covariates: adolescent's ethnicity/race, adolescent's gender, adolescent's age, adolescent's school type, caregivers' working status, travel time to usual health care provider and provider recommendation for HPV vaccine. ^cChange in odds of vaccination for every 1 point increase in attitude score. ^dReversed combined mean score used in the model such that higher score indicates positive attitudes.

and social support and provider recommendation in favor of HPV vaccination. Caregivers of vaccinated adolescents were more likely to report self-efficacy in making an informed decision about HPV vaccination compared with caregivers of unvaccinated adolescents. Caregivers of unvaccinated adolescents expressed lower support for school mandates for HPV vaccination and for vaccina-

tion without caregiver consent. Due to the high internal consistency of the eight items in this measure (see **supplementary table 4**; Cronbach's alpha = 0.84) the reversed combined mean score was used in multivariable analysis.

Table 2 shows the results of the multivariable analysis examining the association of caregiver attitudes and adolescent HPV vac-

Table 4
Association of parental attitudes and adolescent HPV vaccine uptake among adolescents aged 11–17 years (N = 762, 77.2%) from 13 southern states in the United States.

Variables ^a	OR (95% CI) unadjusted	p-value	aOR ^{b,c} (95% CI)	p-value
General vaccine attitudes score	1.41(1.23,1.63)	<0.001	1.46(1.23,1.73)	<0.001
HPV vaccine attitudes score	3.17(2.05,4.92)	<0.001	3.42(2.38,4.92)	<0.001
HPV vaccination attitudes score^d	6.5(4.69,9.01)	<0.001	5.38(3.34,8.67)	<0.001
My child is unlikely to get an HPV-related disease.	0.88(0.8,0.97)	0.01	0.92(0.82,1.02)	0.13
I am uncomfortable talking with my child about sex.	0.95(0.91,1.01)	0.08	0.94(0.89,0.99)	0.03
My child is not sexually active.	0.94(0.88,1)	0.04	0.95(0.88,1.04)	0.26

Abbreviations: HPV; Human Papillomavirus. **Footnotes:** ^aCombined mean score for each scale used in the regression model. ^bModel adjusts for the following previously known socio-demographic and healthcare access covariates: adolescent's ethnicity/race, adolescent's gender, adolescent's age, adolescent's school type, caregivers' working status, travel time to usual health care provider and provider recommendation for HPV vaccine. ^cChange in odds of vaccination for every 1 point increase in attitude score. ^dReversed combined mean score used in the model such that higher score indicates positive attitudes.



Notes: This table summarizes the statistical significance of parameter estimates from multivariable linear regression models predicting attitudes as a function of the covariates shown. *, **, and *** indicate statistical significance at the 0.05, 0.01, and 0.001 levels, respectively. Red cells represent statistically significant negative associations (e.g. among caregivers of vaccinated children, lack of health insurance is associated with more negative general vaccine attitudes at the 0.001 significance level.) Green cells represent statistically significant positive associations (e.g. among caregivers of unvaccinated children, urban residence is associated with more positive HPV vaccination decision-making attitudes at the 0.05 significance level.)

Fig. 4. Correlates of caregiver attitudes, by adolescent HPV vaccination status.

vacination status. After adjusting for covariates related to caregiver and adolescent characteristics, health care access, and provider recommendation, the odds of HPV vaccination were higher for adolescents who had caregivers with more positive attitudes towards adolescent vaccines generally, and towards the HPV vaccine and HPV vaccination decision-making specifically. For caregivers of younger adolescents (9–10 years), only general adolescent vaccination attitudes were predictive of HPV vaccination (Table 3). For caregivers of older adolescents (11–17 years), general adolescent vaccination attitudes as well as HPV vaccine and vaccination attitudes were predictors of HPV vaccination. In this group, caregivers' discomfort with discussing the topic of sex with the adolescent was a negative predictor of HPV vaccination (Table 4).

Attitudes varied systematically with select characteristics of caregivers and adolescents (Fig. 4); associations differed between vaccinated and unvaccinated adolescents. Among the vaccinated,

attitudes toward HPV and general vaccinations tended to be more negative among families minoritized by racial and ethnic status and among those with uninsured adolescents, and more positive for those who had received a provider recommendation for the HPV vaccine. Among the unvaccinated, attitudes tended to be more negative for caregivers with higher education and those attending religious services, adolescents in home/online schooling, and uninsured adolescents.

Discussion

Our study findings underscore the important role of caregiver attitudes in the decision to vaccinate adolescents living in the southern US [8]. In our study, positive caregiver attitudes towards adolescent vaccines in general, towards the HPV vaccine and associated with HPV vaccination decision-making specifically, were

strongly associated with higher odds of HPV vaccination. HPV vaccine and vaccination decision-making related attitudes were independently associated with HPV vaccination, even after controlling for general vaccine attitudes. Overall, most caregivers reported positive general attitudes toward adolescent vaccination in general. This finding is consistent with the high uptake of adolescent vaccines such as Tdap and MenACWY. Notably, caregiver responses reflected greatest concerns with vaccine ingredients, the number of recommended adolescent vaccines, and vaccine side effects, with more caregivers of unvaccinated adolescents reporting these concerns. These concerns mirror those identified in a national survey of parental attitudes towards the HPV vaccine [4]. Hence, public health messaging should focus on emphasizing HPV vaccine safety and need, especially for those caregivers who have not yet initiated HPV vaccination for their adolescent.

Interestingly, our data reveal patterns of shifting concerns with age of the adolescents. While caregivers of younger adolescents (9–10 year olds) had concerns about adolescent vaccines in general, more specific concerns about the HPV vaccine and attitudes related to vaccination decision-making appear to emerge for caregivers of older adolescents (11–17 years). In one study, despite exposure to messaging that emphasized the role of HPV vaccination for cancer prevention, the sexually-transmitted nature of HPV and perceived association with adolescents' sexual activity remained factors in caregiver decision to accept the vaccine [9]. Our study findings suggest caregivers' discomfort in discussing the topic of sex may contribute to delays or refusals of HPV vaccination for age-eligible adolescents. Hence, public health messaging should clarify the reason for initiating HPV vaccination on time and/or prior to sexual debut [9]. The Advisory Committee on Immunization Practices (ACIP) recommendations allow for HPV vaccination initiation as young as age 9 years. Further research is needed to establish whether encouraging early initiation is a viable and effective strategy for increasing HPV vaccination coverage. Interestingly, only a minority of caregivers reported knowing someone with a history of HPV infection. Thus education efforts may also need to correct false perceptions about the rarity of HPV infection, bridge potential knowledge gaps regarding the connection between HPV infection and cancer, and to reduce any associated stigma [32]. In addition, HPV vaccine-specific messaging as opposed to generic vaccination promotion messages may be needed to support caregivers' decision to initiate HPV vaccination for their adolescent children.

Compared with caregivers of unvaccinated adolescents, caregivers of vaccinated adolescents in our study were more likely to feel like they had enough information to facilitate vaccination decision-making and to express support from people they valued and the health provider in favor of vaccination. The need for enhanced training for providers to address caregivers' concerns and provide strong vaccine recommendation is supported by this and other studies [33,34]. Prior findings of our study suggest that healthcare access may influence completion rates [5]. Hence, strategies focused on increasing completion rates need to address access barriers in addition to caregiver attitudes. Caregiver characteristics associated with HPV vaccination in our study may be particularly salient in the context of the southern US, where higher proportions of Black and religious populations and those living below the poverty line have been documented [35,36]. In regions with lower healthcare access (e.g., provider shortages, greater travel times to providers, low health insurance coverage), it may also be important to identify non-healthcare based sources of trust (e.g., school nurses, community organizations, religious leaders etc.) for communicating the importance of HPV vaccination. Social media-based strategies could also be leveraged to promote peer endorsement and social support for vaccination [13]. Our findings suggest limited support among caregivers for school mandates and for policies that propose to

bypass caregiver consent prior to vaccination. We did not assess if the lower support reflected opposition for mandates in general or whether they were reflective of early controversy and failed attempts to mandate the HPV vaccine [37].

Our study has several strengths. First, it provides important insights into caregiver attitudes towards HPV vaccination in the southern US—the region with the lowest HPV vaccination coverage in the US. Second, our study sample is drawn from a nationally-representative panel of households and we use geo-demographically calibrated weights to reduce sampling biases. Third, we explore caregiver attitudes using three distinct measures targeting general adolescent vaccination attitudes, HPV vaccine-specific attitudes and attitudes related to HPV vaccination decision-making. Doing so allows us to explore attitudes that were HPV vaccine specific and distinguish them from general adolescent vaccination attitudes and attitudes related to HPV vaccination decision-making. Future studies may use one or more of these measures to assess caregiver attitudes related to HPV vaccination. Finally, our study represents one of the last large regional surveys on HPV attitudes prior to the COVID-19 pandemic. Thus, it provides useful data for comparisons in an era during which COVID-19 vaccines are recommended for adolescents.

Study limitations with respect to the recall bias resulting from caregivers' report of adolescent vaccination status have been previously described [5]. Other limitations discussed previously include caregivers' self-reported eligibility and potential selection bias. As noted earlier, use of Address-Based Sampling to generate online survey panel as well as application of post-hoc, geo-demographically-calibrated survey weights mitigate the latter limitation. Due to the cross-sectional nature of the survey, we are unable to determine the proportion of caregivers who had positive attitudes a-priori versus as a result of their adolescent's HPV vaccination experience. In particular, attitudes related to concerns about pain during vaccine administration may be influenced by a positive or a negative vaccination experience. Further validation of the measures used in this study with prospective cohorts that allow for the measurement of caregiver attitudes prior to HPV vaccination initiation is important. Our sample included small numbers of vaccinated adolescents in the 9–10 age group and further studies in this age group may be necessary to validate our findings. In addition, our findings do not reflect attitudes of adolescents, and there is currently limited literature on the role that adolescents, especially those who are on the younger end of the spectrum, play in decisions about vaccination.

Conclusion

Public health messaging in the southern US should be tailored to reduce concerns about HPV vaccine safety and to communicate the importance of timely HPV vaccination. Campaigns that deliver HPV vaccine-specific information and messaging to support vaccination decision-making may be more effective at promoting on-time HPV vaccination than those delivering only general vaccine information.

Contributor's statement

Conceptualized the study: LV, JO, SH, LF, EW; Developed protocol and survey: All authors; Led data collection: LV and JO; Data analysis: LV, JO, and YW; Data interpretation: All authors; Manuscript development: LV and JO; Manuscript revisions: All authors. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Funding

The research presented in this manuscript was supported by a cooperative agreement (U01P001095) with the Centers for Disease Control and Prevention. LV receives funding from the National Center for Advancing Translational Sciences of the National Institutes of Health under Award Number KL2TR002554. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or the Centers for Disease Control and Prevention.

Role of Funder/Sponsor

The Centers for Disease Control and Prevention provided input on the study design, interpretation of data, manuscript preparation, and the decision to submit the manuscript for publication but was not directly involved in data collection and analysis.

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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jvacx.2022.100181>.

References

- Walker TY, Elam-Evans LD, Yankey D, Markowitz LE, Williams CL, Fredua B, et al. National, Regional, State, and Selected Local Area Vaccination Coverage Among Adolescents Aged 13–17 Years – United States, 2018. *MMWR Morb Mortal Wkly Rep* 2019;68(33):718–23.
- Elam-Evans LD, Yankey D, Singleton JA, Sterrett N, Markowitz LE, Williams CL, et al. National, Regional, State, and Selected Local Area Vaccination Coverage Among Adolescents Aged 13–17 Years—United States, 2019. *Morb Mortal Wkly Rep* 2020;69(33):1109–16.
- People H. Immunization and Infectious Diseases Published 2020. Accessed 23 June 2020. Objectives 2020. <https://www.healthypeople.gov/2020/topics-objectives/topic/immunization-and-infectious-diseases/objectives>.
- Szilagyi PG, Albertin CS, Gurfinkel D, Saville AW, Vangala S, Rice JD, et al. Prevalence and characteristics of HPV vaccine hesitancy among parents of adolescents across the US. *Vaccine* 2020;38(38):6027–37.
- Vasudevan L, Ostermann J, Wang Y, et al. Predictors of HPV vaccine uptake in the southern United States: Findings from a cross-sectional survey of parents from thirteen states. *Vaccine*. 2021 Dec 17;39(51):7485–7493.
- Walker TY, Elam-Evans LD, Yankey D, Markowitz LE, Williams CL, Fredua B, et al. National, Regional, State, and Selected Local Area Vaccination Coverage Among Adolescents Aged 13–17 Years – United States, 2018. *MMWR Morb Mortal Wkly Rep* 2019;68(33):718–23.
- MacDonald NE. Vaccine hesitancy: Definition, scope and determinants. *Vaccine* 2015;33(34):4161–4.
- Beavis A, Krakow M, Levinson K, Rositch AF. Reasons for Lack of HPV Vaccine Initiation in NIS-Teen Over Time: Shifting the Focus From Gender and Sexuality to Necessity and Safety. *J Adolesc Health* 2018;63(5):652–6.
- Barnes KL, VanWormer JJ, Stokley S, Vickers ER, McLean HQ, Belongia EA, et al. Determinants of human papillomavirus vaccine attitudes: an interview of Wisconsin parents. *BMC Public Health* 2018;18(1). <https://doi.org/10.1186/s12889-018-5635-y>.
- Udesky L. Push to mandate HPV vaccine triggers backlash in USA. *Lancet* 2007;369(9566):979–80.
- Marshall S, Fleming A, Moore AC, Sahn LJ. Views of parents regarding human papillomavirus vaccination: A systematic review and meta-ethnographic synthesis of qualitative literature. *Res Social Adm Pharm* 2019;15(4):331–7.
- Gollust SE, Dempsey AF, Lantz PM, Ubel PA, Fowler EF. Controversy undermines support for state mandates on the human papillomavirus vaccine. *Health Aff* 2010;29(11):2041–6.
- Teoh D. The Power of Social Media for HPV Vaccination–Not Fake News! *Am Soc Clin Oncol Educ Book* 2019(39):75–8. https://doi.org/10.1200/EDBK_239363.
- Committee NVA. 2020 National Vaccine Plan Development: Recommendations From the National Vaccine Advisory Committee. *Public Health Rep* 2020;135(2):181–8.
- Centers for Disease Control and Prevention. Vaccination Coverage among Adolescents (13 – 17 Years). TeenVaxView Web site. <https://www.cdc.gov/vaccines/imz-managers/coverage/teenvaxview/data-reports/index.html>. Published 2019. Updated May 14, 2021. Accessed July 12, 2021.
- Santibanez TA, Nguyen KH, Greby SM, Fisher A, Scanlon P, Bhatt A, et al. Parental Vaccine Hesitancy and Childhood Influenza Vaccination. *Pediatrics* 2020;146(6). <https://doi.org/10.1542/peds.2020-007609>.
- Vasudevan L, Walter E, Swamy G. Vaccine Hesitancy in North Carolina: The Elephant in the Room? *N C Med J* 2021;82(2):130–7.
- Gilkey MB, Reiter PL, Magnus BE, McRee AL, Dempsey AF, Brewer NT. Validation of the Vaccination Confidence Scale: A Brief Measure to Identify Parents at Risk for Refusing Adolescent Vaccines. *Acad Pediatr* 2016;16(1):42–9.
- McRee AL, Brewer NT, Reiter PL, Gottlieb SL, Smith JS. The Carolina HPV immunization attitudes and beliefs scale (CHIAS): scale development and associations with intentions to vaccinate. *Sex Transm Dis* 2010;37(4):234–9.
- Shapiro GK, Holding A, Perez S, Amsel R, Rosberger Z. Validation of the vaccine conspiracy beliefs scale. *Papillomavirus research (Amsterdam, Netherlands)* 2016;2:167–72.
- Cunningham-Erves J, Talbott LL, O'Neal MR, Ivankova NV, Wallston KA. Development of a Theory-based, Sociocultural Instrument to Assess Black Maternal Intentions to Vaccinate Their Daughters Aged 9 to 12 Against HPV. *J Cancer Educ* 2016;31(3):514–21.
- Perez S, Shapiro GK, Tatar O, Joyal-Desmarais K, Rosberger Z. Development and Validation of the Human Papillomavirus Attitudes and Beliefs Scale in a National Canadian Sample. *Sex Transm Dis* 2016;43(10):626–32.
- Thomas TL, Strickland OL, DiClemente R, Higgins M, Williams B, Hickey K. Parental Human Papillomavirus Vaccine Survey (PHPVS): nurse-led instrument development and psychometric testing for use in research and primary care screening. *J Nurs Meas* 2013;21(1):96–109.
- Moss JL, Reiter PL, Brewer NT. HPV vaccine for teen boys: Dyadic analysis of parents' and sons' beliefs and willingness. *Prev Med* 2015;78:65–71.
- Waller Jo, Ostini R, Marlow LAV, McCaffery K, Zimet G. Validation of a measure of knowledge about human papillomavirus (HPV) using item response theory and classical test theory. *Prev Med* 2013;56(1):35–40.
- Roberts JR, Thompson D, Rogacki B, Hale JJ, Jacobson RM, Opel DJ, et al. Vaccine hesitancy among parents of adolescents and its association with vaccine uptake. *Vaccine* 2015;33(14):1748–55.
- von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007;370(9596):1453–7.
- IPSOS KnowledgePanel. <https://www.ipsos.com/en-us/solutions/public-affairs/knowledgepanel>. Accessed July 21, 2020.
- Gilkey MB, Magnus BE, Reiter PL, McRee A-L, Dempsey AF, Brewer NT. The Vaccination Confidence Scale: a brief measure of parents' vaccination beliefs. *Vaccine* 2014;32(47):6259–65.
- Gidengil C, Chen C, Parker AM, Nowak S, Matthews L. Beliefs around childhood vaccines in the United States: A systematic review. *Vaccine* 2019;37(45):6793–802.
- Ipsos. KnowledgePanel: A methodological review. <https://www.ipsos.com/sites/default/files/ipsosknowledgepanelmethodology.pdf>. Accessed June 06, 2021.
- Centers for Disease Control and Prevention. Genital HPV Infection - Fact Sheet. <https://www.cdc.gov/std/hpv/stdfact-hpv.htm>. Updated January 19, 2021. Accessed July 15, 2021.
- Lu P-J, Yankey D, Fredua B, O'Halloran AC, Williams C, Markowitz LE, et al. Association of Provider Recommendation and Human Papillomavirus Vaccination Initiation among Male Adolescents Aged 13–17 Years–United States. *J Pediatr* 2019;206:33–41.e1.
- Lu P-J, Yankey D, Jeyarajah J, O'Halloran A, Meyer SA, Elam-Evans LD, et al. Impact of Provider Recommendation on Tdap Vaccination of Adolescents Aged 13–17 Years. *Am J Prev Med* 2017;53(3):373–84.
- U.S. Census Bureau (2020). *American Community Survey 5-year estimates*. Retrieved from *Census Reporter Profile page for South Region* <<http://censusreporter.org/profiles/02000US3-south-region/>> Accessed May 03, 2022.
- Pew Research Center. Religious Landscape Study, Christians by State Accessed May 03, 2022 <https://www.pewresearch.org/religion/religious-landscape-study/christians/christian/>, ; 2014.
- Haber G, Malow RM, Zimet GD. The HPV vaccine mandate controversy. *J Pediatr Adolesc Gynecol* 2007;20(6):325–31.