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## **Association between Patient Characteristics and HPV Vaccination Recommendation for Postpartum Patients: A National Survey of Obstetrician/Gynecologists**

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## Association between patient characteristics and HPV vaccination recommendation for postpartum patients: A national survey of Obstetrician/Gynecologists

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### ABSTRACT

Human papillomavirus (HPV) vaccination rates in the U.S. are relatively low. Provider recommendation rates for HPV vaccination often vary by patient age and relationship status. Obstetrician/gynecologists (OB/GYNs) represent a key provider group that can recommend the HPV vaccine. This study examined differences in OB/GYN recommendation of HPV vaccination for inpatient postpartum patients by age, parity, and marital status. Data were collected from OB/GYNs nationally via a cross-sectional survey. Participants were randomized to two vignette groups (23-year-old patient or 33-year-old patient). Within each group, participants received 4 vignettes that were identical except for patient marital status (married/not in a committed relationship) and number of children (first/third child), and were asked to indicate HPV vaccination recommendation likelihood on a scale of 0 (definitely would not) to 100 (definitely would). A  $2 \times 2 \times 2$  general linear model with repeated measures was used to examine main and interaction effects of patient age, relationship status, and parity. 207 OB/GYNs were included in the final analyses. Recommendation was high for 23-year-old patients (range: 64.5–84.6 out of 100). When marital status and parity were held constant, recommendation likelihood was higher for the younger vs. older patient and was also higher for patients not in a committed relationship, compared to married patients (all  $p$ -values < 0.001). Differences in recommendation exist when considering age and relationship status, which provides insight into OB/GYN clinical decision-making. Findings highlight the need to address barriers to HPV vaccination recommendation, including awareness of risk factors to consider when recommending the vaccine.

### 1. Introduction

Human papillomavirus (HPV) vaccination rates in the United States are relatively low compared to most other high income countries, with only 54.2% of U.S. adolescents aged 13–17 years completing the recommended number of doses in the series (U.S. Department of Health and Human Services, 2021; Elam-Evans et al., 2020; Falcaro et al., 2021). Routine HPV vaccination is recommended for adolescents ages 11–12, while adolescents and young adults ages 13–26 fall within the routine catch-up age range (Meites et al., 2019). Recent 2019 guidelines indicate

that adults ages 27–45 are eligible for HPV vaccination and advise providers and their patients to engage in shared clinical decision-making (SCDM) to determine if vaccination is the right decision for them (Meites et al., 2019). HPV vaccination rates among adults remain low with only 36.3% of 19–26-year-olds (51.5% of females, 21.2% of males) and 9.7% of 27–45-year-olds (15.8% of females, 3.2% of males) reporting ever receiving any HPV vaccinations in 2018 (Kasting et al., 2020). This is in contrast to other high income countries such as the U.K., where HPV vaccination rates are substantially higher and routine vaccination has resulted in a significant reduction of cervical cancer incidence rates

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among women (Falcaro et al., 2021).

Despite national guidelines for HPV vaccination recommendation, research shows providers often do not offer strong, routine, or consistent recommendations for their patients across all age groups (Gilkey et al., 2016; Vadaparampil et al., 2016; Lake et al., 2019). Primary care providers also demonstrate limited engagement in evidence-based strategies to increase HPV vaccination rates such as assessment of clinic vaccination rates and provision of feedback on vaccination rates to clinic providers (Kasting et al., 2018). Discomfort discussing the HPV vaccine and perceptions that patients and parents do not value the vaccine can influence physician recommendation practices (Gilkey et al., 2015). Relationship status can also influence provider vaccination priority, with providers placing a lower priority on vaccination for patients who are married or in committed relationships (Zimet et al., 2011).

Obstetrician/gynecologists (OB/GYNs) represent a key provider group that can recommend and endorse the HPV vaccine, as many women utilize an OB/GYN as their primary care physician (Rayburn et al., 2014; Mazzoni et al., 2015). HPV vaccination initiation and completion among postpartum women is highest during the first two months after delivery compared to women initiating the vaccine > 2 months after delivery (Kilfoyle et al., 2002). Therefore, the immediate postpartum period (1–2 months post-delivery) represents an opportune time for vaccination education and uptake and can result in higher patient satisfaction and high likelihood of vaccination compliance (Wright et al., 2012). Recent research has also demonstrated that 50–65% of women receive postpartum care and, further, receipt of care at a Federally Qualified Health Center (FQHC) can increase the likelihood of women attending postpartum care visits (Masho et al., 2018; American College of Obstetrics and Gynecologists (ACOG), 2018; Fowler et al., 2016). Standing orders are an effective method to increase vaccine uptake (U.S Preventative Services Task Force, 2019); however, there are currently no national recommendations for standing orders for OB/GYNs regarding HPV vaccination, in general, or in the postpartum clinical setting. Women receiving care from OB/GYN clinics are generally accepting of standing orders for HPV vaccination, yet many wish to discuss the vaccine with their OB/GYN provider before initiating the series (Dempsey et al., 2015), suggesting women place high importance on provider recommendation and discussion. Our study evaluates differences in OB/GYNs' recommendation of HPV vaccination for postpartum patients by patient age, parity, and marital status based on their exposure to a series of clinical vignettes.

## 2. Methods

### 2.1. Participants and procedures

Detailed methods have previously been described (Kasting et al., 2020). Briefly, study participants were OB/GYNs practicing in the U.S. The study took place in October 2019 and consisted of a one-time web-based cross-sectional survey with 73 questions that took approximately 20 min to complete. Participants were compensated with a \$30 gift card. We collected basic demographic information (e.g., age, sex, race/ethnicity, years in practice, HPV vaccination status), information on the OB/GYNs' patient population (e.g., age, race/ethnicity, payment method), and clinic characteristics (e.g., HPV vaccine stocked, FQHC, and geographic location). This study was approved by the Institutional Review Board at the senior author's university and granted exempt status.

### 2.2. Clinical vignette

Participants were randomized into two groups; each group received 4 clinical case studies of a postpartum patient eligible for HPV vaccination. In Group 1, the case studies all involved a 23-year-old patient. In Group 2, the case studies all involved a 33-year-old patient. Within each group, participants received 4 clinical case studies that were identical

except for the patient's marital status (i.e., married vs. not in a committed relationship) and how many children she had (i.e., if she was postpartum after delivering her first vs. third child). Fig. 1 shows randomization and case study procedures. In brief, the clinical case study read:

“The patient is [23/33] years old and is receiving postpartum care at the hospital after delivering her [first/third] child. She has employer-provided health insurance and is [married/not in a committed relationship]. The pregnancy was uncomplicated. She has no documented history of previous HPV vaccination or abnormal cervical cytology. She denies tobacco, alcohol, and drug use. How likely are you to recommend HPV vaccination for this patient on a scale from 0 (definitely would not) to 100 (definitely would)?”

The bolded, bracketed text varied between the case studies. We were then able to calculate a mean likelihood of recommendation, based on participants' responses, on a scale of 0–100.

### 2.3. Statistical analyses

Likelihood of recommending the HPV vaccination (0–100) was described using means and standard deviations. We then completed the following analyses: (1) comparison of the likelihood of recommending the HPV vaccination for patients that were 23 vs. 33 years old using independent samples t-tests; (2) comparison of the likelihood of recommending the HPV vaccination for married vs uncommitted patients using paired t-tests; (3) examination of the main effects of patient age (23 vs. 33), parity (1st child vs. 3rd child), and relationship status (married vs. uncommitted), as well as all interactions were evaluated using a  $2 \times 2 \times 2$  general linear model with repeated measures. The between-subjects variable was patient age; within-subjects variables were parity and relationship status.

## 3. Results

### 3.1. Sample description

A total of 224 OB/GYNs completed the survey; however, only 207 answered the clinical vignette questions and, thus, were included in the analyses. A description of the provider sample is in Table 1 and a description of their clinics is in Table 2. Participants were from 40 states across the U.S. Mean age of the sample was 53.1 (SD = 10.4; range = 31–78), they had an average of 23.3 years practicing medicine (SD = 11.2; range = 0–48), and the majority were male (n = 115; 55.6%), non-Hispanic White (n = 138; 66.7%), and practiced in a clinic located in a suburban area (n = 112; 54.1%). Providers were asked to select the two categories (from multiple categories presented) that described the age group that represented the majority of their patient population; most (n = 166; 80.2%) selected non-Hispanic White as one of the majority categories for their patient population. Most providers reported their patients were in an age range of adults eligible to receive the HPV vaccine. That is, 38.6% (n = 80) reported 18–26-year-olds as one of the two categories that represented the majority of their patients, 50.7% (n = 105) reported 27–30-year-olds as one of the two categories that represented the majority of their patients, and 62.8% (n = 130) reported 31–45-year-olds as one of the two categories that represented the majority of their patients. Providers reported the majority of their patient population had private insurance (69.6%; n = 144). Provider demographic characteristics did not differ significantly between the two randomized groups, nor did they differ by clinic geographic location, FQHC status, or whether the HPV vaccine was stocked in their clinic.

### 3.2. Clinical vignette

Overall, providers reported the highest likelihood of recommending

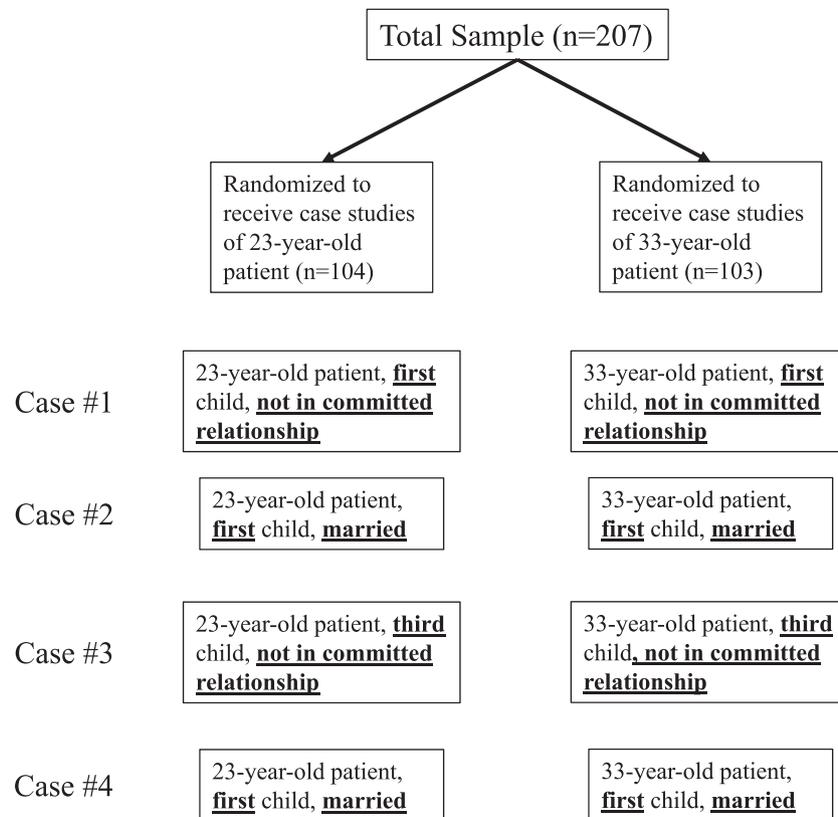


Fig. 1. Flow diagram.

**Table 1**  
Provider Characteristics (N = 207).

Variable	n (%)
Age [Mean; Median; (SD; Range)]	53.1; 53.5 (10.4; 31–78)
Sex	
Male	115 (55.6)
Female	85 (41.1)
Prefer not to answer	5 (2.4)
Missing	2 (1.0)
Race/Ethnicity	
Non-Hispanic White	138 (66.7)
Non-Hispanic Black	4 (1.9)
Non-Hispanic Asian	36 (17.4)
Non-Hispanic Other	7 (3.4)
Hispanic (of any race)	8 (3.9)
Prefer not to answer	12 (5.8)
Missing	2 (1.0)
Years practicing medicine [Mean (SD; Range)]	23.3 (11.2; 0–48)
Personal history of HPV vaccination	
Yes	38 (18.4)
No	164 (79.2)
Unsure	3 (1.4)
Missing	2 (1.0)

the HPV vaccine for a 23-year-old patient who was having her first child and was not in a committed relationship (84.6/100). However, this was not significantly different from a 23-year-old patient who was having her third child and was not in a committed relationship (83.1/100;  $p = 0.397$ ). Average likelihood of recommending the HPV vaccination was significantly higher for the younger patient when marital status and parity were held constant (Fig. 2). Specifically, there was a 15.9-point

difference between the likelihood of recommending the HPV vaccine to a 23-year-old patient vs. a 33-year-old patient who was having her first child and was not in a committed relationship (84.6 vs. 68.7;  $p < 0.001$ ). In paired t-tests, average likelihood of recommending the HPV vaccination was significantly higher for patients who are not in a committed relationship, compared to married patients, when age and parity were held constant (all  $p$ -values  $< 0.001$ ). Fig. 2 displays decreases in likelihood of recommending the vaccination by relationship status, as well as how recommendation likelihood is higher for an unmarried 33-year-old patient than a married 23-year-old patient.

In the general linear model (Table 3), the within-subjects main effects of marital status ( $p < 0.001$ ), and parity ( $p = 0.002$ ), and the between-subjects effect of age ( $p = 0.002$ ) were all statistically significant. The only two-way significant interaction was between parity and marital status ( $p = 0.023$ ), indicating the effect of parity was significant for married ( $p < 0.001$ ), but not unmarried ( $p = 0.30$ ), women. Thus, the main effect for parity only holds for married women. Furthermore, the variable most strongly associated with HPV vaccination recommendation was relationship status, which accounted for 34.4% of the between-subjects variance, higher than both parity and age (each accounting for 4.8% of the variance).

#### 4. Discussion

Given the substantial number of women not previously vaccinated during adolescence, OB/GYNs are an important part of the HPV vaccination decision-making and series initiation and completion process, and the postpartum period offers a unique opportunity for vaccination. Our study focused on examining differences in OB/GYNs' recommendation for HPV vaccination by age, parity, and marital status of their postpartum patients. When examining factors associated with recommendation practices, our results demonstrated that providers were more likely to recommend the HPV vaccine to younger (23 years old) vs. mid-adult patients (33 years old). However, OB/GYN recommendation for

**Table 2**  
Provider clinic description (N = 207).

Variable	n (%)
Age group of the majority of the patient population*	
<i>Younger than 18</i>	5 (2.4)
18–26	80 (38.6)
27–30	105 (50.7)
31–45	130 (62.8)
46–65	59 (28.5)
Over 65	8 (3.9)
Race/ethnicity of the majority of the patient population*	
<i>Non-Hispanic White</i>	166 (80.2)
<i>Non-Hispanic Black</i>	72 (34.8)
<i>Hispanic</i>	80 (38.6)
<i>Asian</i>	17 (8.2)
<i>Other (including multiracial)</i>	12 (5.8)
<i>No definable racial/ethnic majority</i>	8 (3.9)
Payment method of the majority of patients	
<i>Private insurance/HMO</i>	144 (69.6)
<i>Medicaid</i>	46 (22.2)
<i>Uninsured/Self-pay</i>	4 (1.9)
<i>Other</i>	2 (1.0)
<i>Unsure</i>	1 (0.5)
<i>No definable payment majority</i>	8 (3.9)
<i>Missing</i>	2 (1.0)
HPV vaccine stocked in clinic	
<i>Yes</i>	162 (78.3)
<i>No</i>	44 (21.3)
<i>Missing</i>	1 (0.5)
Clinic is Federally Qualified Health Center (FQHC)	
<i>Yes</i>	20 (9.7)
<i>No</i>	146 (70.5)
<i>Unsure</i>	39 (18.8)
<i>Missing</i>	2 (1.0)
Geographic location	
<i>Rural</i>	26 (12.6)
<i>Urban</i>	66 (31.9)
<i>Suburban</i>	112 (54.1)
<i>Missing</i>	3 (1.4)

\*Percentages do not add up to 100% because participants were asked to mark the two most common.

HPV vaccination was strongly influenced by relationship status, such that providers were more likely to recommend the vaccine to a 33-year-old patient who was *unmarried* vs. a 23-year-old *married* patient. Thus, in addition to OB/GYNs serving as an important mechanism of HPV vaccination for young adult women, this study also reveals some important predictors of their recommendation behaviors that warrant further study.

As in previous research (Petrušek et al., 2020), our results demonstrate an increase in recommendation likelihood in the 23-year-old age patient group compared to those in the 33-year-old age group. This difference may be due to current ACIP guidelines, where 23-year-olds, but not 33-year-olds, fall into the routine catch-up age group for HPV vaccination (Meites et al., 2019). In fact, the recommendation for individuals who are older than 26 is for patients and providers to engage in SCDM and this recommendation is relatively recent (Meites et al., 2019), which likely accounts for the lower likelihood of recommendation for those in the 33-year-old age group in our study when examining differences by patient age. However, while recommendation for the 33-year-old patient was lower than for the 23-year-old patient, recommendation likelihood for the 33-year-old patient was relatively high in our study, given the Advisory Committee on Immunization Practices (ACIP) guidelines for this group, particularly when taking into consideration patient relationship status.

In our study, OB/GYNs appeared to base their recommendations on the patient's relationship status, such that they would be less likely to recommend the vaccine to those who were in a committed romantic relationship. This is problematic, given that 24.4% of individuals in committed relationships also report being sexually involved with someone other than their partner at some point in their relationship; in heterosexual married relationships, extramarital sex occurs in nearly 25% of these relationships (Lehmiller, 2015; Blow and Hartnett, 2005). Many individuals may believe they are in a monogamous relationship and that their significant other shares similar values; however, their partner may be engaging in risky sexual behaviors (Lehmiller, 2015; Levine et al., 2018; Conley et al., 2013) and previous research has also demonstrated that 4% of people report being in consensual non-monogamous relationships (Levine et al., 2018). Multiple studies have shown the majority of the non-monogamous behavior in a relationship is without their partner's consent (Lehmiller, 2015; Blow and Hartnett, 2005). Any of these scenarios ultimately put all parties involved at an increased risk for exposure to HPV, highlighting the need to discuss HPV vaccination, regardless of relationship status. Additionally, the likelihood of divorce is higher in younger individuals (ages 15–24) compared to individuals ages 25–34 (26% vs. 20%) and compared to those 35 and older, further illustrating the importance of HPV vaccination in younger patients who may be married at the time of their visit (Allred, 2019). Furthermore, women who are in a long-term committed monogamous relationship are less likely to have been exposed to vaccine-type infection and therefore may derive greater benefit from HPV vaccination. Relationships can end due to divorce or the death of a partner and HPV vaccination can provide protection when individuals begin to consider and pursue new partnerships.

Given the evidence of relationships that may include additional partners, either through mutually agreed-upon open relationships or infidelity and changes in status (e.g., divorce, death of partners), current relationship status may not be an accurate proxy for assessing a patient's current and/or future risk of HPV exposure. While SCDM for HPV vaccination is recommended for patients between the ages of 27–45, this may create confusion among providers and result in them only discussing vaccination with patients they perceive as high-risk. If relationship status is the metric used to determine vaccination recommendation, providers may need additional tools and training to assist them in assessing which patients are considered high risk. Previous research suggests that providers are unsure of what information to emphasize during the SCDM discussion with patients about HPV vaccination (Hurley et al., 2021), which is likely to result in patients omitting specific information about their relationships or sexual behavior. Additionally, similar to our findings, providers are less likely to recommend the HPV vaccine to adults 27–45 years old who report being in a monogamous relationship (Hurley et al., 2021).

Lack of effective patient-provider communication may limit provider awareness of patient relationships. For example, if a patient tells their provider that they are in a committed relationship and they do not provide further details such as whether or not they are in an open relationship or if their partner has a history of infidelity, the provider may not be able to make an accurate assessment of the patient's risk. Patient omission of this information may be due to the lack of a strong patient-provider relationship, the lack of provider elicitation of values, and inadequate information exchange (Lewis et al., 2011). These patient-centered communication techniques can result in increased patient trust, patient understanding, satisfaction, and better relationships with providers (Street et al., 2009), all of which are necessary for clinical decision-making regarding initiation of the HPV vaccine among postpartum women.

Unlike relationship status, providers in our study did not appear to consider parity when making a recommendation for HPV vaccination. Physicians were more likely to recommend the vaccine to the 33-year-old patient that was not in a committed relationship and was having their first child (69%), compared to the married 23-year-old patient with

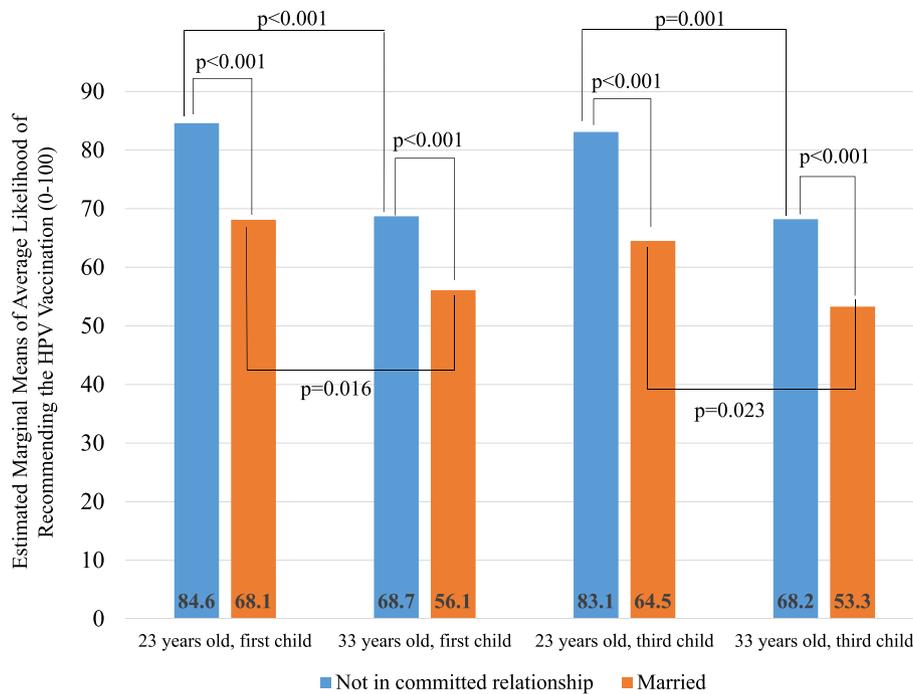


Fig. 2. Average likelihood of OB/GYN HPV vaccination recommendation by patient relationship status, parity, and age.

**Table 3**  
General Linear Model of OB/GYN HPV Vaccination Recommendation by Patient Relationship Status, Parity, and Age.

	F-value	p-value	Partial Eta Squared
<b>Main Effects</b>			
Relationship Status	105.33	<0.001	0.344
Parity	10.05	0.002	0.048
Age	10.17	0.002	0.048
<b>Interaction Effects</b>			
Relationship Status*Age	0.995	0.320	0.005
Parity*Age	0.528	0.468	0.003
Relationship Status*Parity	5.29	0.023	0.026
Relationship Status*Parity*Age	0.377	0.540	0.002

3 children (64%). This is contrary to ACIP recommendations, where guidelines recommend routine catch-up vaccination for patients younger than 27 and SCDM for patients 27 years and older (Meites et al., 2019). Because it appears that providers may be inappropriately (or inadvertently) using relationship status as a surrogate measure of sexual risk behavior and therefore HPV risk, it may be beneficial to educate OB/GYNs on how to have a conversation about risky sexual behavior during the SCDM discussion. Similarly, previous research has also demonstrated that young adult women (18–26 years old) in long-term monogamous relationships report not needing the HPV vaccine due to low perceived risk for HPV and are less likely to intend to receive the HPV vaccine compared to single or unmarried women (Thompson et al., 2016; Thompson et al., 2017; Waters et al., 2021). Currently, there is limited research on HPV vaccination recommendation and parity, particularly among OB/GYNs, however, our results suggest that there is a need for increased OB/GYN awareness and education that emphasizes the possibility of sexual behavior outside of relationships or with multiple partners and parity as a risk factor for HPV infection. Further, standing orders for OB/GYNs to recommend HPV vaccination to postpartum patients within the eligible age range for vaccination regardless of relationship status and parity could also improve vaccination rates among this population. Standing orders for OB/GYNs could include a focus on women within the immediate (1–2 months) postpartum period,

which often results in patient acceptance and compliance with HPV vaccination (Wright et al., 2012).

**5. Strengths & limitations**

Considering ACIP guidelines for individuals 27–45 years old were released in 2019, there is limited research focused on physicians’ use of SCDM for recommendation of HPV vaccination among the mid-adult population, particularly among OB/GYN providers. Therefore, our study provides a valuable contribution to the literature focused on this new population. It also provides insight into physician recommendation practices for postpartum women in the OB/GYN setting, where there is a unique opportunity for vaccination education and uptake. Additionally, our study focused on a national sample of OB/GYNs, rather than being limited to particularly geography or health care system.

While our study has many strengths, some limitations should be considered. First, these data are self-reported and actual vaccination of patients could not be assessed. Second, we recruited OB/GYN providers using a survey sampling company whose participants may not reflect providers nationwide. Indeed, compared to licensed OB/GYNs in the United States, our sample had a higher proportion of males (55.8% vs. 42.9% nationally), and non-Hispanic White participants (67.0% vs. 60% nationwide) (Association of American Medical Colleges, 2019). We also did not ask providers to describe their specific recommendation practices, including how they discuss the HPV vaccination with their patients, therefore it is difficult to know the specific communication techniques they utilize with patients and if they are engaging in SCDM with their mid-adult patients. Finally, our study did not assess the impact of the patient-provider relationship on HPV vaccination recommendation.

**6. Conclusions**

Overall, HPV vaccination recommendation likelihood was relatively high among our OB/GYN participants for the 23-year-old patient (range: 64.5%–84.6%), suggesting this provider group appears to be open to recommending the HPV vaccine for their younger, eligible patients. However, recommendation likelihood was relatively lower for the 33-

year-old patient (range: 53.3%-68.7%). Further, differences in recommendation likelihood exist when considering important patient factors such as relationship status and these differences provide important insight into clinical decision-making among OB/GYNs. Our study suggests that OB/GYNs are making risk-based recommendations for HPV vaccination, however, making risk calculations for HPV infection based on patient relationship status is not a recommended method of clinical decision making. Our findings highlight the need to address potential barriers to HPV vaccination recommendation among this provider specialty, including awareness of which factors to consider when recommending the vaccine and potential lack of effective patient-provider communication, which would improve SCDM.

Training programs that involve motivational interviewing have improved provider communication about HPV vaccination, provider self-efficacy, and have helped address patient vaccine hesitancy (Reno et al., 2018; Wermers et al., 2021). Additional research has also utilized educational fact sheets in conjunction with motivational interviewing (MI) and has resulted in higher vaccine acceptance and uptake (Reno et al., 2019). Therefore, communication training that emphasizes MI could be adapted for OB/GYNs who regularly see postpartum patients. Training programs could incorporate MI techniques to utilize with the catch-up vaccination group (ages 18–26). However, given that the recommendation for those outside of the routine catch-up age (ages 27–45) is SCDM, standardized education that trains OB/GYNs on how to implement this among their postpartum patient population is needed and would be beneficial. Further, the utilization of MI and SCDM techniques in conjunction with educational materials could improve HPV vaccination rates among postpartum women.

Sexual activity is a factor that providers are encouraged to avoid when recommending HPV vaccination with younger patients, and instead focus on how the HPV vaccination prevents cancer (Fleming et al., 2018; Vu et al., 2020). However, given the new recommendations for the mid-adult patient population (ages 27–45 years) and the differences in patient likelihood of engagement in these important risk factors, this is a topic that may be more appropriate to discuss when having a conversation with a mid-adult patient about the HPV vaccine. Given that providers may have been trained to recommend the vaccine a certain way, which de-emphasizes the connection between sex and HPV infection (Kasting et al., 2017; Sussman et al., 2015), our results suggest a need for training that is focused on different communication strategies to employ for specific, older patient age groups.

Additionally, considering ACIP guidelines for the HPV vaccine for patients aged 27–45 are relatively new and little is known about OB/GYN recommendation for this patient group and postpartum women, future studies and interventions should focus on further exploring the SCDM process between OB/GYNs and postpartum women of various ages. Such future research would assist in the development of decision aids for providers to utilize in the clinical setting and improve vaccination among this patient population.

#### CRedit authorship contribution statement

**Paige W. Lake:** Writing – original draft, Writing – review & editing, Visualization, Investigation. **Katharine J. Head:** Conceptualization, Methodology, Data curation, Writing – review & editing. **Shannon M. Christy:** Conceptualization, Methodology, Data curation, Writing – review & editing. **Andrea L. DeMaria:** Conceptualization, Methodology, Data curation, Writing – review & editing. **Erika L. Thompson:** Conceptualization, Methodology, Data curation, Writing – review & editing. **Susan T. Vadaparampil:** Conceptualization, Methodology, Data curation, Writing – review & editing, Supervision. **Gregory D. Zimet:** Conceptualization, Methodology, Formal analysis, Data curation, Writing – review & editing, Supervision. **Monica L. Kasting:** Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Supervision, Project administration, Funding acquisition.

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#### Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Gregory D. Zimet has served as a paid consultant to Sanofi Pasteur for work on the Adolescent Immunization Initiative and Merck for work on HPV vaccination. Outside of the present work Gregory Zimet has served as an external advisory board member for Merck and Moderna and as a consultant to Merck. In addition, Gregory Zimet, Katharine Head, and Monica Kasting have received investigator-initiated research funding from Merck administered through Indiana University and Purdue University. Erika L. Thompson has served as a paid consultant to Merck for work on HPV vaccination. Shannon Christy serves as an unpaid Advisory Board Member of the HPV Cancers Alliance (a non-profit organization). The remaining 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.

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