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### Authors

Hopfer, Suellen  
Wright, Margaret E  
Pellman, Harry  
[et al.](#)

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RESEARCH PAPER



# HPV vaccine recommendation profiles among a national network of pediatric practitioners: understanding contributors to parental vaccine hesitancy and acceptance

Suellen Hopfer<sup>a,b,c</sup>, Margaret E. Wright<sup>d,e</sup>, Harry Pellman<sup>f,g</sup>, Richard Wasserman<sup>h</sup>, and Alexander G. Fiks<sup>d,i,j,k,l,m</sup>

<sup>a</sup>Department of Population Health and Disease Prevention, Irvine, CA, USA; <sup>b</sup>Institute for Clinical & Translational Science, USA; <sup>c</sup>Chao Family Comprehensive Cancer Center, University of California, Irvine, CA, USA; <sup>d</sup>Pediatric Research in Office Settings (PROS), Itasca, IL, USA; <sup>e</sup>American Academy of Pediatrics (AAP), Itasca, IL, USA; <sup>f</sup>University of California, Irvine, CA, USA; <sup>g</sup>Edinger Medical Group, University of California, Fountain Valley, CA, USA; <sup>h</sup>Department of Pediatrics, Larner College of Medicine, University of Vermont, Burlington, VT, USA; <sup>i</sup>The Center for Clinical Effectiveness, USA; <sup>j</sup>Policy Lab, USA; <sup>k</sup>Pediatric Research Consortium, USA; <sup>l</sup>Department of Biomedical and Health Informatics, Children's Hospital of Philadelphia, USA; <sup>m</sup>Department of Pediatrics at the Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA, USA

## ABSTRACT

**Background:** Practitioner communication is one of the most important influences and predictors of HPV vaccination uptake. The objective of this study was to conduct a latent class analysis characterizing pediatric practitioner HPV recommendation patterns.

**Methods:** Pediatric practitioners of the American Academy of Pediatrics' (AAP) Pediatric Research in Office Settings (PROS) national network completed an online survey where they were presented with 5 hypothetical vignettes of well child visits and responded to questions. Questions asked about their use of communication strategies, assessments about the adolescent patient becoming sexually active in the next 2 years for decision-making about HPV vaccine recommendation, and peer norms. Latent class analysis characterized practitioner subgroups based on their response patterns to 10 survey questions. Multinomial logistic regression examined practitioner characteristics associated with each profile.

**Results:** Among 470 respondents, we identified three distinct practitioner HPV vaccine recommendation profiles: (1) Engagers (52%) followed national age-based guidelines, strongly recommended HPV vaccination, and perceived peers as strongly recommending; (2) Protocol Followers (20%) also strongly recommended HPV vaccination, but were less likely to engage families in a discussion about benefits; and (3) Ambivalent HPV Vaccine Recommenders (28%) delayed or did not recommend HPV vaccination and were more likely to use judgment about whether adolescents will become sexually active in the next two years. Practicing in a suburban setting was associated with twice the odds of being an Ambivalent Recommender relative to being an Engager (OR = 2.2; 95% CI:1.1–4.1).

**Conclusions:** Findings underscore the importance of continued efforts to bolster practitioner adoption of evidence-based approaches to HPV vaccine recommendation especially among Ambivalent Recommenders.

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## KEYWORDS

HPV vaccine; latent class analysis; vaccine hesitancy; clinician communication

## Background

Despite the widespread availability and known benefits of the HPV vaccine, rates of vaccination remain suboptimal at 50.4%–65.9%, depending upon geographical area.<sup>1</sup> These rates lag significantly relative to those for other adolescent vaccines, including tetanus, diphtheria, acellular pertussis (Tdap) (87%) and meningococcal conjugate quadrivalent vaccine (MCV4) (81%). Pediatric practitioners including not only pediatricians, but also pediatric nurses, physician assistants, and medical assistants are optimally positioned to discuss the benefits of timely HPV vaccination with parents of youth. However, how pediatric practitioners engage families in discussions of HPV vaccine initiation varies considerably.<sup>2–5</sup>

A practitioner's recommendation is one of the most consistent predictors of HPV vaccination.<sup>6–9</sup> Public health leaders and the 2012–2013 President's cancer panel prioritized improving healthcare practitioners' communication as a key

strategy for increasing HPV vaccine rates.<sup>10</sup> In a national survey of parent perceptions of HPV vaccination, the most commonly cited reason for not vaccinating was the practitioner not having recommended the HPV vaccine (56% of parents cited this reason).<sup>11</sup> Parent reports suggest that one third of adolescent girls (36%) and more than half of adolescent boys (58%) do not receive a recommendation from their provider.<sup>11,12</sup> Parents expect vaccine recommendations to come from their child's health care provider; if the HPV vaccine is not recommended explicitly, is recommended passively, is recommended as different from other adolescent vaccines, or is recommended in the same conversation as questions about sexual debut,<sup>4,13</sup> any or all of these approaches can lead parents to interpret HPV vaccination as unnecessary or as stigmatizing.<sup>2,4</sup> Thus, how practitioners recommend HPV vaccination can uniquely influence parental acceptance of vaccination.<sup>14</sup>

This study was designed to investigate in more detail the patterns of practitioner communication about HPV vaccine recommendation. Using a methodological technique called latent class analysis<sup>15</sup> (LCA), this approach categorizes distinct pediatric practitioner subgroups based on their survey responses regarding how they recommend the HPV vaccine, perceived peer norms, and judgments about when adolescents will become sexually active. This latent class or person-oriented approach, unlike traditional multivariate models, involves studying individuals as a whole on the basis of their response patterns across a number of individual characteristics relevant for a particular phenomenon (e.g., practitioner recommendation patterns).

## Results

### Respondent characteristics

Respondents ( $n = 470$ ) ranged in age from 29 to 79 years (mean = 53 years), and the majority were female and Caucasian (see Table 1). Respondents practiced in nearly all US States ( $N = 47$ ). The respondent characteristics are consistent with those of participants from recent surveys of primary care pediatricians from the general AAP membership.<sup>16</sup> PROS members are predominantly primary care pediatricians. We do not know the composition of the analytic sample with regards to practitioner type (physician, nurse practitioner, or physician assistant), since this question was not included in the anonymous survey.

### Pediatric practitioner HPV vaccine recommendation profiles

Latent class analysis yielded three distinct practitioner vaccine recommendation patterns based on responses to use of various communication strategies, judgement about whether adolescent patients will become sexually active in the next two years, and peer norms after reading hypothetical medical case scenarios (see Table 2). We classified more than half of the respondents (52%) as “Engagers” because they reported being highly engaged with families around HPV vaccination. Engagers had high

**Table 1.** Respondent demographics and practice characteristics.

|                                 | N = 470 |
|---------------------------------|---------|
| Mean age of respondent (SD*)    | 53 (10) |
| Mean years in practice (SD*)    | 22 (10) |
| Practitioner gender, %          |         |
| Female                          | 62%     |
| Male                            | 38%     |
| Practitioner race/ethnicity, %  |         |
| Caucasian                       | 80%     |
| Asian                           | 8%      |
| Hispanic                        | 6%      |
| Black                           | 4%      |
| Hawaiian/Pacific Islander       | 1%      |
| Other race                      | 1%      |
| % Medicaid-insured patients     |         |
| > 25%                           | 64%     |
| ≤ 25%                           | 36%     |
| Practice setting, %             |         |
| Suburban                        | 42%     |
| Urban non-inner-city            | 26%     |
| Urban inner-city                | 13%     |
| Rural                           | 19%     |
| US states represented in survey | 47      |

\*SD = standard deviation

**Table 2.** Parameter estimates for a 3-class model describing Practitioner HPV vaccine recommendation profiles ( $N = 470$ ).

|  | Ambivalent<br>Recommenders | Protocol<br>Followers | Engagers             |
|--|----------------------------|-----------------------|----------------------|
| <i>Latent Class Prevalence</i>                                       | 28% ( $N = 138$ )          | 20%<br>( $N = 85$ )   | 52%<br>( $N = 245$ ) |
| <b>Probability of a “Yes” response (<math>\rho</math> parameter)</b> |                            |                       |                      |
| Strongly recommend   | .02                        | <b>.93</b>            | <b>.88</b>           |
| Recommend same day   | <b>.63</b>                 | <b>.99</b>            | <b>.97</b>           |
| Recommend 3 adolescent<br>vaccines at the same time                  | <b>.61</b>                 | <b>.72</b>            | <b>.93</b>           |
| Benefits of vaccination: cancer<br>protection                        | <b>.85</b>                 | .48                   | <b>.99</b>           |
| Benefits of vaccination: genital<br>wart protection                  | .52                        | .10                   | <b>.76</b>           |
| Benefits of vaccination: antibody<br>argument                        | .37                        | .09                   | <b>.78</b>           |
| Positive tone  | .44                        | .21                   | <b>.89</b>           |
| Peers strongly recommend   | .15                        | <b>.67</b>            | <b>.61</b>           |
| Peers view HPV as important  | .16                        | <b>.50</b>            | <b>.53</b>           |
| Sexual maturity judgment   | <b>.89</b>                 | .45                   | .49                  |

Item response probabilities (i.e.,  $\rho$  parameter estimates) range between 0 and 1. Estimates that are close to 0 or 1 (e.g., .99) reflect a high degree of certainty that the response pattern is highly characteristic of this class.

response probabilities for strongly recommending HPV vaccine initiation to parents of youth ( $\rho = .88$ ), recommending vaccination at today’s visit ( $\rho = .97$ ), and recommending HPV vaccination at the same time as other adolescent vaccines ( $\rho = .93$ ). This subgroup of practitioners, more than any other, was inclined to describe the following benefits when talking to parents about HPV vaccination: cancer protection ( $\rho = .99$ ), genital wart protection ( $\rho = .76$ ), and a stronger antibody response when vaccinating at a younger age ( $\rho = .78$ ), and were more likely to do so using a positive tone ( $\rho = .89$ ). Engagers perceived peer practitioners as also strongly recommending HPV vaccination to parents of youth ( $\rho = .61$ ), and were less likely to use a risk-based approach (e.g., assessing whether the patient will become sexually active in the next two years to decide when to recommend HPV vaccination) ( $\rho = .49$ ).

We classified a second group of practitioners as “Protocol Followers”, representing the 20% of respondents who reported being highly likely to strongly recommend HPV vaccine initiation to parents of youth ( $\rho = .93$ ), at today’s visit ( $\rho = .99$ ), and recommending HPV vaccination at the same time as other adolescent vaccines ( $\rho = .72$ ). However, practitioners of this subgroup were less likely to discuss the benefits of vaccination with parents such as cancer protection ( $\rho = .48$ ), genital wart protection ( $\rho = .10$ ), or emphasizing a stronger antibody response ( $\rho = .09$ ). Protocol Followers perceived peers as strongly recommending HPV vaccination to parents of youth ( $\rho = .67$ ), and were much less likely to use a sexual maturity judgment of the adolescent patient to determine when to recommend HPV vaccination ( $\rho = .45$ ). Overall, Protocol Followers showed adherence to national age-based vaccine recommendation guidelines for practitioners, but were less likely to engage families in conversations about HPV vaccine benefits.

We describe a third practitioner subgroup, which included over one fourth of respondents (28%) as “Ambivalent Recommenders.” This subgroup reported a very low probability of strongly recommending HPV vaccine initiation or recommend at all to parents of youth ( $\rho = .02$ ). In contrast to Engagers and Protocol Followers, Ambivalent Recommenders were likely to report using judgment about whether the adolescent patient will become sexually active in the next two years to decide when to recommend HPV vaccination

**Table 3.** Description of practitioner profile characteristics\*.

|   | Ambivalent Recommenders<br>(28%) | Protocol Followers<br>(20%) | Engagers (52%) | <i>p</i> value  |
|---|----------------------------------|-----------------------------|----------------|-----------------|
| Total # practitioners   | 138                              | 85                          | 245            |                 |
| <i>Practitioner characteristics</i>   |                                  |                             |                |                 |
| Mean age  | 53                               | 53                          | 53             | .98             |
| Mean years in practice  | 22                               | 22                          | 22             | .98             |
| % Female practitioners  | 59% (77/131)                     | 54% (45/84)                 | 67% (163/245)  | .07             |
| % Caucasian practitioners   | 87% (113/130)                    | 78% (65/83)                 | 89% (217/245)  | .06             |
| <i>Practice characteristics</i>   |                                  |                             |                |                 |
| Suburban location   | 53% (70/132)                     | 34% (29/85)                 | 39% (95/243)   | <i>p</i> < .001 |
| Rural location  | 17% (23/132)                     | 21% (18/85)                 | 20% (49/243)   | .75             |
| >25% Medicaid patients  | 52% (68/132)                     | 81% (68/84)                 | 64% (157/244)  | <i>p</i> < .001 |
| Located in a CDC designated disparity state   | 42% (53/127)                     | 55% (45/82)                 | 52% (121/234)  | .11             |
| <i>HPV vaccine survey responses</i>   |                                  |                             |                |                 |
| Ranked HPV vaccine as most important relative to other adolescent vaccines            | 2% (3/132)                       | 13% (11/85)                 | 9% (22/245)    | <i>p</i> < .001 |
| Usually discuss HPV vaccination at mild sick, non-febrile visits with 11–12 year olds | 28% (37/132)                     | 58% (49/85)                 | 62% (152/245)  | <i>p</i> < .001 |
| Reported Paid for Performance (Financial incentive)                                   | 14% (18/132)                     | 11% (9/85)                  | 11% (28/245)   | .48             |
| Reported reimbursement (Financial incentive)  | 17% (23/132)                     | 14% (12/85)                 | 17% (42/245)   | .48             |
| Reported generate profit (Financial incentive)  | 17% (22/132)                     | 13% (11/85)                 | 17% (42/245)   | .42             |
| Reported financial incentive doesn't apply  | 60% (80/132)                     | 72% (61/85)                 | 63% (155/245)  | .31             |
| Reported HPV vaccination financial barriers in practice                               | 12% (16/132)                     | 15% (13/85)                 | 10% (24/245)   | .38             |

\*Note that some covariates have missing data, and number of respondents within those cells do not always equal the total number of practitioner respondents within a specific profile.

( $p = .89$ ). Ambivalent recommenders were less likely to recommend all 3 adolescent vaccines at the same time and in the same way ( $p = .61$  as compared to  $.93$  and  $.72$  for Engagers and Protocol Followers, respectively) and were also less likely to emphasize the importance of vaccinating against HPV the same day they recommended it ( $p = .63$  as compared to  $.99$  and  $.97$  for Engagers and Protocol Followers, respectively). Ambivalent Vaccine Recommenders did not perceive peer practitioners as prioritizing HPV vaccination ( $p = .16$ ) and did not perceive their peers as strongly recommending HPV vaccine initiation to parents of youth ( $p = .15$ ).

### Practitioner recommendation profile characteristics

Table 3 describes the demographics, practice characteristics, and vaccine attitudes of each the three practitioner subgroups. Four characteristics significantly differed across groups – ranking of the 3 adolescent vaccines, recommending HPV vaccination at mild, non-febrile sick visits, and two practice characteristics. Ambivalent Recommenders were significantly less likely to rank HPV vaccination as the most important relative to the other two adolescent vaccines, and, ambivalent recommenders were less likely to recommend HPV vaccination during mild, non-febrile sick child visits in comparison with the other practitioner subgroups. With respect to practice characteristic differences, Ambivalent Recommenders were significantly less likely to report seeing many (>25%) Medicaid patients, and were more likely to practice in suburban locations.

### Predictors of practitioner recommendation class membership

To further describe the 3-class model of HPV recommendation profiles, we entered practitioner demographics and practice level characteristics into a multinomial logistic regression model. As reported in Table 4, relative to the Engager profile

(the reference group), Protocol Followers had less than half the odds of being Caucasian and more than three times the odds of seeing >25% Medicaid patients. Ambivalent Vaccine Recommenders had twice the odds of practicing in a suburban setting relative to Engagers.

### Discussion

Systematic reviews<sup>4,18</sup> and qualitative studies<sup>5,19,20</sup> have pointed to the uniquely influential role that pediatric practitioners play in recommending HPV vaccination to parents of youth. Given the growing number of parents hesitant to vaccinate their children who likely turn to practitioners for reassurance,<sup>21,22</sup> it is important to characterize practitioners' communication about HPV vaccination. Previous research characterizing the quality of practitioner communication about vaccination has primarily been conducted using a variable centered approach with the implicit assumption of an underlying "average" practitioner.<sup>15,23–25</sup> By contrast, the latent class approach used in this study highlights the uniqueness of practitioner communication patterns, uncovering unique similarities within subgroups and unique differences between them, reflecting a person- rather than a variable-centered approach.<sup>15,26</sup>

We found that both Engagers and Protocol Followers – comprising a majority of respondents in our sample (72%) – recommended the HPV vaccine in ways that were consistent with age-based national guidelines.<sup>27</sup> However, Protocol Followers were less likely to discuss the specific benefits of timely HPV vaccination with parents compared to Engagers. Although announcing vaccines that are due without extensive conversation may be effective in promoting vaccination with some parents,<sup>14,28,29</sup> this subgroup of practitioners employed fewer strategies to address parental vaccine hesitancy. This speaks to what Dempsey and colleagues report in a recent review that practitioners' brief strong endorsements may work better with parents already on board while for reluctant parents motivational

**Table 4.** Multinomial logistic regression model of covariates predicting practitioner HPV vaccine recommendation profiles.

|   | Ambivalent Recommenders | Protocol Followers    | Engagers<br>(reference) | p-value  |
|---|-------------------------|-----------------------|-------------------------|----------|
|   | OR (95% CI)*            | OR (95% CI)*          |                         |          |
| Practitioner age                        | 1.0 (0.9, 1.02)         | 1.0 (0.9, 1.02)       | 1.0                     | .71      |
| Practitioner gender (female)            | 0.7 (0.4, 1.2)          | 0.6 (0.3, 1.02)       | 1.0                     | .13      |
| Practitioner race/ethnicity (Caucasian) | 0.64 (0.3, 1.4)         | <b>0.4</b> (0.2, 0.8) | 1.0                     | .05      |
| Suburban location                       | <b>2.2</b> (1.1, 4.1)   | 0.9 (0.4, 2)          | 1.0                     | .03      |
| Rural location                          | 1.5 (0.6, 3.2)          | 1 (0.3, 1.4)          | 1.0                     | .20      |
| Located in CDC disparity state**        | 0.7 (0.4, 1.2)          | 1.1 (0.6, 2)          | 1.0                     | .27      |
| See >25% Medicaid patients              | 0.7 (0.4, 1.2)          | <b>3.1</b> (1.4, 6.9) | 1.0                     | p < .001 |
| Report financial barriers in practice   | 1.2 (0.5, 2.5)          | 1.5 (0.6, 3.6)        | 1.0                     | .67      |

\*CI = confidence interval; OR = odds ratio

\*\*CDC designates a US state that has less than 60% of adolescents vaccinated for HPV as a disparity state. Twenty-three states are currently designated as a disparity state.<sup>17</sup>

interviewing may more effectively address parent concerns and questions.<sup>29</sup>

Ambivalent HPV Vaccine Recommenders (28% of our sample) reported approaches to HPV vaccination that contradict national guidelines.<sup>27,30</sup> Two prior studies identified 27% and 65% of pediatricians respectively who did not strongly recommend HPV vaccine initiation to parents of youth.<sup>3,28</sup> Our results fall in the lower end of this range. Extending the work of prior studies, our findings characterize the approaches of Ambivalent HPV Vaccine Recommenders. Notably, Ambivalent Recommenders incorporated judgements about when youth will become sexually active and, correspondingly, the youth's perceived risk of acquiring HPV into their decision regarding vaccine recommendation. This strategy ignores evidence that sexual debut is difficult to predict.<sup>31</sup> Furthermore, it ignores calls to end the era of HPV exceptionalism and to adopt the practice of recommending all adolescent vaccines the same way and at the same time.<sup>32</sup>

Additional characteristics that distinguished Ambivalent Recommenders is they perceived peer practitioners as not following national age-based recommendations and not viewing the importance of HPV vaccine as equivalent to other adolescent vaccines. Peer norms play an underappreciated role in bringing about changes in recommended practice guidelines especially in today's predominantly group practice structures. The bee-in-the-bonnet metaphor (agitated; to keep talking about something again and again because you think it's important) describes how practice behavior is most likely to change when a physician, nurse, or practice manager with a special interest in a particular issue, procedure, or disease champions practice change.<sup>33</sup> Physician champions have been discussed in the literature as assuming key roles in nationwide quality improvement initiatives including HPV vaccination.<sup>34</sup> Our results support the importance of targeting peer practice norms as part of communication training. The overall recommendation patterns of Ambivalent Recommenders present a potential barrier to improving HPV vaccination rates, and also highlight behaviors that might be targeted in future studies.

In this study, we identified not only practitioner but practice level characteristics that could be targeted for practitioner trainings. Practicing in a suburban office predicted a two-fold higher odds of Ambivalent Recommender practice patterns. This finding is striking in light of data showing differences in HPV vaccine uptake by urbanicity. An Ohio study<sup>35</sup> and the NIS Teen 2016 report<sup>1</sup> have shown that suburban practitioners are less likely to routinely and strongly recommend HPV vaccine initiation to parents of youth. Although we were not able to correlate

practitioner practice profiles with vaccine receipt in this study, NIS Teen 2016 reports have indicated HPV vaccination disparities by metropolitan statistical area (MSA) status.<sup>1</sup> Adolescent vaccine coverage among those who live outside of MSA central cities is 16 percentage points lower than those who live in MSA central cities, with 5–8% point vaccination decreases observed in MSA non-central city areas that reflect suburban practice settings. Access to vaccination has not been able to account for these MSA status discrepancies. Future studies may want to investigate whether hesitant parents are more prevalent in areas frequenting suburban practices.

Consistent with previous research,<sup>18,36</sup> Ambivalent Recommenders were less likely to recommend HPV vaccine initiation at mild, non-febrile sick visits relative to Engagers and Protocol Followers. Given that adolescents sometimes forgo preventive care and that vaccination at all visits is associated with much higher rates,<sup>4</sup> this approach also decreases the likelihood that adolescents will be vaccinated prior to HPV exposure.

### Limitations

Our study had several limitations. First, our latent class analysis was based on responses to hypothetical scenarios requiring respondents to make judgements about common practice scenarios, rather than observed medical encounters. However, the approach of using hypothetical case scenarios was used as a strategy to overcome the potential for social desirability bias (a tendency for practitioners to underreport how they actually practice or to change their practice when observed in real medical setting encounters). A second limitation was that the survey was conducted among pediatric practitioners belonging to a research network and had a modest response rate. We compared the characteristics of our PROS survey respondents to those reported in a recent publication of US American Academy of Pediatrics members' attitudes regarding sun protection counseling<sup>16</sup> and the practitioner characteristics were similar. Although the practitioner characteristics were similar, it is possible that the prevalence of the identified recommendation profiles might be different among a general population of pediatric practitioners. Nevertheless, the PROS practice-based research network represents practitioners from virtually all US states, and the groups of practitioners identified are likely to broadly reflect pediatric health care providers. Finally, practitioner HPV vaccine recommendation profiles were not linked with vaccination rates, which is a focus for future work.

## Conclusions

The 2012–2013 President’s Cancer Panel as well as a national coalition of more than 75 organizations dedicated to reducing the incidence and mortality from HPV, have prioritized improving healthcare practitioners’ communication as a key strategy for increasing HPV vaccine acceptance and uptake.<sup>10,37</sup> Healthcare clinicians, particularly those in pediatric settings, play a critical role in HPV vaccine uptake but also, in recognizing parental hesitancy.<sup>38</sup> While this study does not directly investigate the reasons behind parental hesitancy, it does point to a possible contributor namely, that practitioners’ approaches to HPV vaccine recommendation vary considerably with a sizeable minority communicating ambivalent recommendations. Practitioner vaccine recommendation ambivalence together with risk-based approaches may in part contribute to parental hesitancy. Equally, strong, consistent vaccine recommendation (Engagers and Protocol Followers) may in part contribute to HPV vaccine acceptance.<sup>29</sup> While moving toward having all pediatric practitioners make HPV vaccine recommendations routinely and consistently, simply making a recommendation is not sufficient.<sup>29</sup> The specific language the provider uses, the tone, the timeliness and whether they treat HPV vaccination in the same way as other adolescent vaccines to communicate recommendations can have major effects on parents’ vaccine attitudes and whether they will have their children vaccinated. Our study demonstrated that while a majority of practitioners follow age-based vaccine recommendation guidelines, a sizable minority of practitioners, over 25%, did not routinely and strongly recommend HPV vaccination to parents of youth (11–12 year olds). The recommendation pattern among this subgroup of pediatricians was characterized by using judgement about when the patient was becoming sexually active to decide when to recommend HPV vaccination. To bolster vaccination rates, our results indicate that future studies should test interventions to address use of effective HPV vaccine recommendation strategies among clinicians who may be Ambivalent Recommenders as identified in this study. Furthermore, our findings suggest that suburban pediatric offices in particular may benefit from practitioner training in optimal HPV vaccine recommendation practices.

## Materials and methods

### Participants & survey design

Members of the American Academy of Pediatrics’ (AAP) Pediatric Research in Office Settings (PROS) national practice-based research network were asked to complete an online, anonymous survey in the Spring of 2016. The survey was designed to better understand how pediatric practitioners communicate with parents of adolescents about HPV vaccination. Survey respondents read 5 hypothetical vignettes describing well-child visits with varying parent interactions. Participants responded to each vignette answering 10 questions.<sup>1</sup> The author team of pediatricians and communication experts drafted the clinical vignette case scenarios based on clinical experience and pilot tested the vignettes with 10 pediatricians asking for qualitative feedback. An example vignette describing parental hesitancy reads as follows: “A

mother brings in her 11-year-old son for a health maintenance visit. He has a normal exam. You discuss preventive health measures, including the recommended vaccines for his age group: Tdap, MCV4, and HPV. The mother is hesitant for her son to get vaccinated against HPV.” Of these vignettes, the first was specifically focused on how practitioners respond to vaccine hesitant parents. Others described scenarios that varied by child age, child gender, child ethnicity, and the number of shots that were due.

### Measures

Practitioners responded to ten questions after reading each vignette. The ten questions asked about 3 domains theorized to be relevant for practitioner communication about HPV vaccination: 7 communication strategies, 2 peer practice norm questions, and 1 question about the use of whether the practitioner makes judgments about a patient’s sexual maturity in the next two years when discussing HPV vaccine recommendation (see Table 5 for measures). Inclusion of these survey questions in the study were guided by a practitioner HPV vaccine communication model developed by the team of authors whose expertise is grounded in pediatric practice and communication theory. The model emphasizes the importance of (a) practitioner communication style,<sup>3,14,39</sup> (b) peer norms,<sup>13,40,41</sup> and (c) whether practitioners base vaccine recommendation in part on judgement of a patient’s sexual maturity in the next two years (a risk-based approach).<sup>42</sup> The survey was sent to 1,586 PROS members, of which 488 responded (31%). Of these, 7 declined to participate and 11 did not provide well child care to 11–12 year olds, leaving a total of 470 respondents with analyzable data. The human subjects review board at the University of California, Irvine and the American Academy of Pediatrics approved the study.

### Statistical analysis

IBM SPSS (version 24, Armonk, NY) was used to conduct descriptive analyses of pediatric practitioner demographics. Latent class analyses (LCA) were used to identify subgroups (or “classes”) of practitioners characterized by similar approaches to HPV vaccine recommendation. PROC LCA SAS 9.4<sup>15,17,43</sup> software (Cary, NC) was used to conduct the analyses. Ten measures from the survey were used to conduct LCA analyses (see Table 5). To identify the number of vaccine recommendation profiles that fit the structure of the data best, we ran two, three, four, five, and six-class models.<sup>2</sup> Optimal number of vaccine recommendation classes were determined by examining (1) goodness of fit indices, where lower values reflect a more optimal model fit, and, (2) patterns of rho ( $\rho$ ) estimates or item response probabilities that yielded clinically meaningful profiles.<sup>15</sup> The item response probabilities ranged between 0 and 1 and represent the probability of a yes response to each of the survey items. The three-class model was identified as having the best fit based on goodness of fit indices as well as interpretability, meaningfulness of the resulting practitioner profiles.

Practitioner and practice characteristics were subsequently included into the latent class model to investigate predictors of

**Table 5.** Communication, peer norm, and risk-based indicators for the latent class model of practitioner HPV vaccine recommendation profiles.

| Indicators   | Response Options   |
|--|--|
| <i>COMMUNICATION</i>   |  |
| Recommendation Strength  | 0 = includes<br>(a) would not mention<br>(b) would recommend waiting<br>(c) would recommend but not push<br>1 = I would strongly recommend HPV vaccination   |
| Timeliness   | 0 = Vaccinate at a future encounter<br>1 = Vaccinate today   |
| Recommend all 3 adolescent vaccines same time  | 0 = no<br>1 = I would normalize HPV vaccination (e.g., by offering and recommending it at the same time as the other required adolescent vaccines Tdap and MCV4)   |
| Emphasize cancer protection  | 0 = no<br>1 = I would emphasize the importance of the HPV vaccine including discussing the cancers and diseases that it protects against   |
| Emphasize genital wart protection  | 0 = no<br>1 = I would mention the vaccine protects against genital warts   |
| Emphasize strong antibody response when vaccinating at younger age   | 0 = no<br>1 = I would mention that vaccinating at a younger age results in a stronger antibody response  |
| Use positive tone when recommending HPV vaccine  | 0 = no<br>1 = I would talk with the parent in an enthusiastic and hopeful tone mentioning that it's exciting to have a vaccine that protects against cancer  |
| <i>PEER NORMS</i>  |  |
| Peer Descriptive Norms<br>"peer practitioner HPV vaccine recommendation practices"   | 0 = includes<br>(a) Most of the practitioners in our clinic would not mention/discuss the HPV vaccine;<br>(b) Most of the practitioners in our clinic would not recommend HPV vaccination routinely;<br>(c) Most of the practitioners in our clinic would recommend the HPV vaccine, but be neutral/noncommittal<br>1 = Most of the practitioners in our clinic would strongly recommend HPV vaccination |
| Peer Injunctive Norms<br>"peer practitioner HPV vaccine recommendation views"  | 0 = includes<br>(a) Unimportant;<br>(b) Not essential nor unessential for good health;<br>(c) Important but not essential (for good health)<br>1 = includes<br>(a) Absolutely essential (for good health) and<br>(b) Essential for continuing to be seen as a patient in the practice  |
| <i>RISK BASED APPROACH</i>   |  |
| Using clinical judgment about whether patient will become sexually active in the next 2 years to adjust HPV vaccine recommendation | 0 = Unlikely or very unlikely to adjust HPV vaccine recommendation based on judgment about whether child will become sexually active in next two years<br>1 = Very likely or likely to adjust HPV vaccine recommendation based on judgment about whether child will become sexually active in next two years   |

latent class membership. Multinomial logistic regression was used to assess whether practitioner and practice characteristics predicted latent class membership.<sup>44</sup> Four practitioner characteristics (gender, age, race/ethnicity, number of years in practice) and four practice characteristics (seeing >25% of Medicaid patients, practicing in a Centers of Disease Control (CDC) designated disparity state, reporting financial barriers to stocking the HPV vaccine, primary practice setting) were entered individually first, and subsequently, sequentially added to the model. *P*-values <.05 were considered significant.

## Notes

1. Vignette descriptions are available upon request to corresponding author.
2. Goodness of fit indices are available upon request.

## Abbreviations

|      |                                       |
|------|---------------------------------------|
| CI   | confidence interval                   |
| HPV  | human papillomavirus                  |
| LCA  | latent class analysis                 |
| OR   | odds ratio                            |
| PROS | Pediatric Research in Office Settings |

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## Contributor's Statement

Dr. Hopfer contributed to conceptualization and design of the study, developed the survey, conducted the statistical analyses, interpreted the data, and drafted the manuscript.

Dr. Wright assisted with editing the survey instrument, created it within the online survey platform, deployed the electronic survey to AAP members, and edited manuscript drafts.

Dr. Pellman contributed to discussions on conceptualization of the study design, contributed to survey development, and edited manuscript drafts. Dr. Wasserman contributed to discussions on conceptualization of the study design, co-developed the survey instrument and focus of survey questions and clinical vignettes, and edited manuscript drafts.

Dr. Fiks contributed to discussions on conceptualization of the study design, co-developed the survey and focus of survey questions and clinical vignettes, and edited manuscript drafts.

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