RESEARCH PAPER

Exploring variation in parental worries about HPV vaccination: a latent-class analysis

Melissa B. Gilkey^a, Divya Mohan^b, Ellen M. Janssen^c, Annie-Laurie McRee^d, Melanie L. Kornides^e, and John F. P. Bridges^f

^aDepartment of Health Behavior & Lineberger Comprehensive Cancer Center, University of North Carolina, Chapel Hill, NC, USA; ^bHealth Economics Research Unit, Institute of Applied Health Sciences, University of Aberdeen, Aberdeen, UK; ^cPatient Centered Outcomes, Icon PLC, Ellicott City, MD, USA; ^dDepartment of Pediatrics, University of Minnesota, Minneapolis, MN, USA; ^eDepartment of Family and Community Health, University of Pennsylvania School of Nursing, Philadelphia, PA, USA; ^fDepartment of Biomedical Informatics, The Ohio State University College of Medicine, Columbus, OH, USA

ABSTRACT

Background. Prior research has identified diverse worries that parents have about HPV vaccination. We sought to understand how parents prioritize worries and to identify subgroups of parents according to shared patterns of worry.

Methods. We surveyed a national sample of 431 U.S. parents of adolescents who reported never having talked to their child's healthcare provider about HPV vaccination. Parents completed a best-worst scaling experiment designed to prioritize 11 common worries about HPV vaccination. The experiment used a balanced incomplete block design to present 11 choice tasks consisting of repeated subsets of worries. We used conditional logistic regression to prioritize worries and latent class models with 1–10 classes to identify subgroups of parents with shared worries.

Results. Parents most often worried about long-term side effects of HPV vaccination, which about one-third (36%) ranked as their top worry. Other common top-ranked worries were how new the vaccine is (12%), motives of drug companies (12%), short-term side effects (10%), and that it may be unnecessary (10%). Latent class analyses suggested a relatively large number of distinct worry profiles, with most classes characterized by a worry about long-term side effects in combination with one other worry.

Discussion. Our findings suggest that providers should be prepared to address concerns about long-term side effects, as this worry was prioritized across many subgroups of parents. However, to best address worry, a tailored, rather than targeted, communication approach may be needed.

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Introduction

HPV vaccination offers safe, effective, and long-lasting protection against infections associated with over 40,000 cancers in the United States (US) each year.¹ However, only 39% of U.S. adolescents complete the HPV vaccine series prior to age 13, despite national recommendations for routine administration.² Parental declination of HPV vaccination is one reason for low uptake. Over one-third of parents decide to refuse or delay HPV vaccination for their adolescents at some point, although many of these parents go on to accept the vaccine at a later time.^{3,4} In an effort to understand and prevent declination, many studies – including our own – have assessed parents' knowledge, attitudes, intentions, and experiences with regard to HPV vaccination.^{3,5–8} Reasons that parents report for not getting their adolescents vaccinated represent a wide range of individual, interpersonal, and health systems-level barriers. These barriers include the lack of a healthcare provider's recommendation, the need for more information, and concerns about safety and side effects.^{6,8–12}

Despite the vast literature on barriers, gaps remain in our understanding of how parents prioritize the concerns that might lead to declination or how these concerns may co-occur across

populations of parents. A better understanding of such patterns could be useful for audience segmentation to inform targeted communication campaigns.^{13,14} This study sought to prioritize parental concerns about HPV vaccination and to assess patterns of concern. We focused on a subset of concerns that rose to the level of “worries” instead of more general barriers to vaccination so as to make our findings most relevant to HPV vaccine declination.^{15,16} By applying preference elicitation methods, we sought to provide a new perspective on parents' HPV vaccination worries to inform the development of targeted approaches to meeting parents' communication needs.

Results

Sample characteristics

Our sample included similar proportions of parents of sons (55%) and daughters (45%). Most children were non-Hispanic white (63%), non-Hispanic black (9%), or Hispanic (20%, Table 1). About one-third (34%) of parents in our sample reported that their child had received one or more doses of HPV vaccine. Our sample included a comparable number of male and female parents (56% male). Parents were from diverse educational

Table 1. Sample characteristics ($n = 431$).

	<i>n</i>	(%)
Child characteristics		
Sex		
Male	235	(55)
Age (years)		
11–12	146	(34)
13–15	148	(34)
16–17	137	(32)
Race		
Non-Hispanic white	271	(63)
Non-Hispanic black	41	(10)
Hispanic	85	(20)
Other	34	(8)
HPV vaccination status		
1 or more doses	146	(34)
Parent characteristics		
Sex		
Male	240	(56)
Educational attainment		
High school degree or less	181	(42)
Some college, no degree	126	(29)
College degree or more	124	(29)
Household characteristics		
Annual income		
<\$35,000	98	(23)
\$35,000–\$74,999	128	(30)
≥\$75,000	205	(48)
Region		
Northeast	68	(16)
Midwest	105	(24)
South	157	(36)
West	101	(23)

backgrounds, with 42% having attained a high school degree or less education. Parents resided in all regions of the US.

Prioritization of worries

Table 2 displays the results of the conditional logistic analysis and ranks worries in order from most to least worrying. The more positive the coefficient associated with the worry, the more often parents ranked it as their top worry. Parents were most often worried about *long-term side effects* of HPV vaccination, with about one-third (36%) of parents ranking it first in the list of worries. Other worries that parents commonly ranked as first were *how new the vaccine is* (12%), *motives of drug companies* (12%), *short-term side effects* (10%), and that it *may be unnecessary* (10%). Other worries were less often ranked as first, including *getting too many vaccines* (7%), *encouraging sexual activity* (5%), the *opinion of the child* (3%), *having to talk about sex* (3%), and *making the child upset* (3%). Parents least often prioritized *opinions of family members* as their top worry (2%).

Segmentation into latent classes

We estimated scale-adjusted latent class models that varied between 1 to 10 classes. The statistical fit of the model improved with the addition of each class (BIC for 1-class model: 22557, BIC for 10-class model: 20962, Supplemental Table), and classes largely persisted across models with each addition. In Table 3, we present the 5-class model to illustrate the more common classes.

The 5-class model suggested distinct parental profiles, with each centered around different clusters of worries. Over one-

Table 2. Best-worst scaling prioritization of worries about HPV vaccination.

	Frequency of choice		Conditional logit model		
	Most worrisome	Least worrisome	β	SE	Conditional Probability
Long-term side effects	1182	76	2.86	0.04	36%
How new the vaccine is	603	175	1.50	0.04	12%
Motives of drug companies	547	249	1.40	0.04	11%
Short-term side effects	473	162	1.22	0.04	10%
It may be unnecessary	503	261	1.22	0.04	10%
Getting too many vaccines	416	255	0.70	0.04	7%
Encouraging sexual activity	414	459	−0.20	0.04	4%
Opinion of the child	119	552	−1.55	0.04	3%
Having to talk about sex	151	606	−1.62	0.04	3%
Making the child upset	138	721	−2.15	0.04	3%
Opinions of family members	75	1105	−3.39	0.04	2%

quarter of parents (28%) fell into Class 1, which we labeled “Vaccine Harm” worriers, who were primarily concerned about *long-term side effects*. A similar proportion of parents (29%) fell into Class 2, or “Industry” worriers, who prioritized concerns about *long-term side effects* and *motives of drug companies*. A smaller proportion (15%) fell into Class 3, or “General Risk” worriers, who were worried about *long-term side effects* and *encouraging sexual activity*. About one-quarter of parents (23%) fell into Class 4, or “Novelty” worriers, who were concerned about *long-term side effects* and *how new the vaccine is*. Fewest parents (5%) fell into Class 5, or “Sex” worriers, who were concerned about *having to talk about sex* and *encouraging sexual activity*.

Discussion

Our study confirmed that parents’ worries about HPV vaccination are diverse, while suggesting that worry about long-term side effects is particularly prominent. Over one-third of parents in our sample prioritized *long-term side effects* as their top worry of the 11 they considered, and this worry was consistently shared across groups of parents identified through latent-class analysis. Other top-ranked worries included *how new the vaccine is*, *motives of drug companies*, and *short-term side effects*, and these factors also suggested concern about HPV vaccine-related harms. The persistence of these concerns is perhaps surprising for a vaccine that is ten years post-licensure and has an excellent safety profile; after over 100 million doses delivered and extensive surveillance, HPV vaccination is not a new vaccine and has not been found to be associated with serious short- or long-term side effects.¹⁷ Nevertheless, stories questioning the safety of HPV vaccination are common in traditional and social media^{18–21} and may have an outsized influence on parents’ HPV vaccination decisions when compared to more positive stories about the vaccine’s preventive benefits.²² The general tendency to perceive negative information as more credible and worthy of attention than positive information,²³ combined with a strong desire to protect their children’s health, may explain why parents’ worry about the side effects of HPV vaccination lingers.

Table 3. Conditional probability of endorsing worries by latent class membership (5-class model).

	Classes of Parental Worry				
	1. Vaccine harms	2. Industry	3. General risk	4. Novelty	5. Sex
Class Size	28%	29%	15%	23%	5%
Long-term side effects	60%	22%	19%	42%	–
How new the vaccine is	–	–	–	15%	–
Motives of drug companies	–	33%	–	–	–
Short-term side effects	–	–	–	–	–
It may be unnecessary	–	–	–	–	–
Getting too many vaccines	–	–	–	–	–
Encouraging sexual activity	–	–	44%	–	30%
Opinion of the child	–	–	–	–	–
Having to talk about sex	–	–	–	–	29%
Making the child upset	–	–	–	–	–
Opinions of family members	–	–	–	–	–

Note. Data are shown for worries that in combination make up >50% of parents within the class.

In addition to prioritizing parents' worries overall, we also sought to identify patterns of worry that might inform audience segmentation for future public health campaigns to promote HPV vaccination. Interestingly, the results of latent class analyses suggested a relatively large number of worry profiles; with each new class we added to the model, model fit improved while previous classes tended to persist. These findings suggest that HPV vaccination worries are not easily categorized into a small number of worry "profiles," and that audience segmentation by parental worry may be an unsuitable approach for organizing public health communication campaigns.

Our study focused specifically on parents who reported having never discussed HPV vaccination with their child's healthcare providers, and yet about one-third of these parents reported that their child had initiated HPV vaccination. Our study does not provide data to explain this pattern of reports. It may be that these respondents either were not the parent who attended the child's vaccination visit or that they agreed to vaccination without perceiving a discussion as having taken place. Alternatively, respondents may have forgotten the discussion or could have misreported children's vaccination status; however, prior research suggests that most parents accurately recall whether their child has initiated HPV vaccination.²⁴ We conducted a sensitivity analyses of our best-worst scaling experiment to focus specifically on parents of unvaccinated children; we found consistency in the prioritization of worries, which provides evidence to support the robustness of our findings.

In terms of implications for practice, our findings suggest that healthcare providers and others who counsel parents about HPV vaccination should be prepared to identify parents' specific questions and, as needed, to discuss the worry of long-term side effects. Based on high-quality evidence,^{25,26} providers are currently advised to introduce the topic of adolescent vaccination using brief, presumptive statements about vaccines for which the child is due.²⁷ Many parents will proceed with vaccination without the need for further discussion. Others, however will raise questions, which may be, in part, motivated by worries such as those about long-term side effects. Emerging evidence suggests that providers can increase parents' intention to vaccinate by using research-tested messages that seek to normalize HPV vaccination.²⁸

For example, they might say, "HPV vaccine is one of the most studied medications on the market. This vaccine is safe, just like the other vaccines given at this age." Given the diversity of parents' worry profiles identified in this study, providers likely need a tailored approach to communication in which they start by identifying the nature of the parent's concern, rather than a targeted approach that assumes that parents will fall into one of a small number of discrete groups.

In terms of implications for preference elicitation research, our study demonstrates the value of using latent class analysis to complement best-worst scaling. This approach allowed for the disaggregation of worries, such as encouraging sexual activity, that were almost entirely overshadowed by worry about long-term side-effects in the overall best-worst scaling analysis. Subsequent latent class analyses confirmed that sex was a dominant worry for only a very small proportion of parents, but a secondary concern to some others. Latent class analysis in this way can allow for a layering of prioritization that may be useful for extending standard best-worst scaling approaches.

Limitations

This study used best-worst scaling methods to provide novel, quantitative data on how parents who have not yet discussed HPV vaccination with their children's providers prioritize their worries about HPV vaccination. As in many preference elicitation studies, the primary limitation of our research is a focus on "stated" preferences, or what parents believe would worry them, as opposed to "revealed" preferences, or what would worry them when actually considering HPV vaccination for their children in real time. We limited our sample to parents who reported having never talked to their children's healthcare providers about HPV vaccination so as to best understand the worries that providers could expect to encounter when broaching the topic with parents. It is possible that parents who have already discussed HPV vaccination with their children's providers may have different worries about the vaccine; additional research will be needed to assess the generalizability of our findings to other groups of parents. Finally, it is noteworthy that our best-worst scaling experiment was limited to parents' worries about HPV vaccination, and excluded considerations, including access to care, the

need for more information, or lack of a healthcare provider recommendation, that may present additional barriers to timely HPV vaccination.

Conclusions

Research on HPV vaccine-related communication has made substantial progress in recent years, with evidence-based strategies for introducing adolescent vaccines now firmly established.^{25,26} The next challenge is to identify strategies for effectively and efficiently addressing questions or concerns that may arise about HPV vaccination, including those raised by parents who are less inclined to vaccinate. Findings of our study suggest that providers and others who promote HPV vaccination should be prepared to address common worries, including those about harms, but should also expect parents' worries to be diverse. By using preference elicitation methods, this study provides novel data for understanding how parents prioritize their worries about HPV vaccination, thereby informing ongoing efforts to better support parents in their decision making about HPV vaccination.

Methods

Participants and procedures

Data for our study came from the Adolescent Cancer Prevention Communication Survey, which was a national survey of parents of adolescents ages 11–17; the survey included items for the present study, as well as items for a series of other studies related to HPV vaccination and skin cancer prevention.^{29–31} Participants were members of GfK's KnowledgePanel, a probability-based, online panel designed to be representative of adults living in US households.³² This standing online panel is constructed via random digit dialing and probabilistic, address-based sampling to cover households with and without landline telephones. The company provides Internet service and an Internet-enabled device to households without these resources; this incentive is provided across multiple surveys for the duration of participation in the panel. Participation by households with established Internet access is incentivized with points that can be redeemed for small cash payments. The response rate for the overall survey of 1,259 parents was 59%, as calculated using the American Association for Public Opinion Research (AAPOR) formula

4.³³ Additional details about the overall survey have been reported previously.^{29–31}

In this study, eligible respondents were parents who reported never having talked to their child's healthcare provider about HPV vaccination. We focused on these parents to understand the perspectives that providers are most likely to encounter when they first broach the topic of HPV vaccination. A total of 431 parents were screened as eligible and completed our best-worst scaling experiment. Harvard Pilgrim Health Care Institute's Institutional Review Board approved the study protocol (#657,902–11).

Experimental design and measures

We prioritized parental worries about HPV vaccination using best-worst scaling, a stated preference method that combines data across a series of choice tasks to rank ideas, attributes, or messages (or "objects").³⁴ BWS is designed to evaluate trade-offs across objects, rather than the structural relationships between them as might be assessed through classical testing theory. Compared to traditional rating or ranking, BWS takes advantage of an individual's tendency to respond more consistently to extreme views, and provides simpler tasks for respondents to comprehend and complete.^{34–37} We used case 1 (or "object" case) BWS in which all objects have one level, and each choice task presents a subset of these objects to the respondent.

To develop objects for our experiment, we first searched the literature to identify worries that parents commonly report having about HPV vaccination (Table 4).^{5,10,12,38,39} We defined a *worry* as thoughts or images that are negatively affect-laden and relatively uncontrollable.⁴⁰ We labeled each worry with a name and developed a brief (1–2 sentence) description. Next, we conducted cognitive interviewing with a convenience sample of parents ($n = 13$) to improve the clarity of our labels and descriptions.

The BWS experiment had two parts. First, respondents completed an orientation exercise that asked them to read each label and description and to indicate which worries they might have about HPV vaccination (yes/no). Worries were presented in a randomized order, and the purpose of the task was to encourage respondents to read worry descriptions. The orientation exercise was not designed to provide data for the

Table 4. Worries that parents might have about HPV vaccine.

I would worry about...	This means....	Source
Short-term side effects	I would worry that the HPV vaccine would cause problems that last for a few days, like pain or swelling.	3,39,44,45
Long-term side effects	I would worry that the HPV vaccine would cause lasting health problems.	3,39,44
Making the child upset	My child does not like getting shots. I would worry that my child would complain or get upset about having to get the HPV vaccine.	46
Motives of drug companies	I would worry that drug companies are pushing the HPV vaccine to make a profit.	39,47,48
Having to talk about sex	I would worry that getting the HPV vaccine for my child would lead to uncomfortable conversations about sex.	10
Opinions of family members	I would not want to make a decision about the HPV vaccine that other members of my family disagree with.	49
Encouraging sexual activity	I would worry that my child would think that getting the HPV vaccine means it is okay to have sex.	5,10,38
Opinion of the child	Children should make their own decisions about the HPV vaccine. I would worry that my child is not old enough to fully participate in the decision at age 12.	45,49
It may be unnecessary	I would worry that the HPV vaccine might not have any real benefit for my child.	12,38,50
How new the vaccine is	I would worry that the HPV vaccine is too new.	39,45,50
Getting too many vaccines	Children can get the HPV vaccine at the same time as other vaccines. I would worry about getting too many vaccines at one visit.	51,52

“Which of the following would worry you the most and least about getting the HPV vaccine for a 12-year-old child?”

Most		Least
	Long-term side effects	
	Encouraging sexual activity	
	How new the vaccine is	
	Opinion of the child	
	Motives of drug companies	

Figure 1. Sample choice task.

analysis, but rather to engage respondents. Second, respondents saw a series of 11 BWS choice tasks which each consisted of a subset of 5 worries (Figure 1). They were then prompted to consider a vaccination decision for a hypothetical 12-year-old child: “Which of the following would worry you the most and least about getting the HPV vaccine for a 12-year-old child?” We used a balanced incomplete block design to ensure that worries occurred and co-occurred an equal number of times for each respondent. We specified the age of the child based on CDC recommendations for routine administration by age 12.

Analysis

We used conditional logistic regression to analyze data from the BWS choice tasks to prioritize parents’ worries about HPV vaccination. We derived conditional probabilities for each worry, or the percentage of parents who ranked it as most worrying. Our analyses assumed sequential best-worst decision-making which holds that respondents first chose what they were most worried about and then chose what they were least worried about from the remaining options. For ease of interpretation, the coefficients were rescaled as conditional probabilities of endorsing each worry ranging from 0–100 using the following conversion:

$$\text{Conditional probability}_i = \frac{e^{U_i}/(e^{U_i} + a - 1)}{\sum_{j \in C} e^{U_j}/(e^{U_j} + a - 1)},$$

where U_j is the coefficient for worry j from the choice model, $a = 5$ (or the number of worries that are shown per choice set), and $C = 11$ (or all worries included in the BWS exercise). The conditional probabilities lie on a ratio scale which means that a worry with conditional probability at 10% is twice as influential as a worry with a conditional probability at 5%.

We followed our overall best-worst scaling analysis with a sensitivity analysis in which we limited our sample to parents of children who had not yet initiated HPV vaccination. The resulting prioritization of worries was very similar, with conditional probabilities within one percentage point of the original findings (data not shown). Given

this correspondence, we do not report further on this analysis.

We next performed a latent class analysis to understand the extent to which parents could be characterized by different clusters of worries. Data were analyzed using scale-adjusted latent class logistic regression models. Latent class analysis groups respondents into a pre-specified number of classes based on the preferences displayed in the choice tasks. This approach allows for the estimation of class-specific preference parameters and of the probability of class membership.⁴¹ We used scale-adjusted models because they consider both scale variance and preference heterogeneity in the estimation of the classes to ensure that classes reflect preference heterogeneity and not simply differences in response consistency.⁴² In contrast, unadjusted latent class models can form segments that mainly differ in terms of variance scale (i.e., response consistency), but do not differ substantially in terms of overall preference patterns. Respondents could have essentially the same preferences, but appear to have different preference estimates due to different response errors; the larger the response error the smaller the estimated preference estimates.⁴³ We estimated scale adjusted latent class models that ranged from a one-class model to a ten-class model in Latent GOLD Choice 5.

Disclosure of potential conflicts of interest

No potential conflict of interest was reported by the authors.

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ORCID

Annie-Laurie McRee <http://orcid.org/0000-0001-6588-5995>

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