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## Parents' health beliefs and HPV vaccination of their adolescent daughters<sup>☆</sup>

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### ABSTRACT

Though many studies have documented correlates of HPV vaccine acceptability, our study is one of the first to examine correlates of vaccine initiation. The current study aimed to identify modifiable correlates of HPV vaccine initiation among adolescent girls in high risk communities and whether correlates varied by race and urban/rural status. In 2007, we conducted a cross-sectional survey of 889 parents of adolescent girls aged 10–18 living in areas of North Carolina, USA with high cervical cancer rates. We analyzed data using logistic regression. Health Belief Model constructs were associated with HPV vaccine initiation in multivariate analyses, including doctor's recommendation to get HPV vaccine, perceived barriers to obtaining HPV vaccine, and perceived potential vaccine harms. While exploratory stratified analyses suggested that many of the same parent beliefs were important correlates of HPV vaccine initiation regardless of racial group or urban/rural status, a few differences did exist. These potentially modifiable beliefs offer well-defined targets for future interventions designed to increase HPV vaccine coverage. However, the beliefs' relative importance may differ between racial groups and regions.

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### Introduction

Cervical cancer is highly preventable, yet it remains prevalent within certain geographical areas of the United States, with higher rates among African American and rural women (Akers, Newmann, & Smith, 2007; Benard, Coughlin, Thompson, & Richardson, 2007; Saraiya et al., 2007). Almost all cervical cancer is caused by persistent infection with human papillomavirus (HPV) (Schiffman & Castle, 2003), primarily HPV types 16 and 18. The United States Advisory Committee on Immunization Practices currently

recommends three doses of quadrivalent (types 6, 11, 16, 18) HPV vaccine be administered routinely to females 11–12 years of age, as well as catch-up doses for 13 to 26-year-olds who have not yet received the vaccine (Markowitz et al., 2007). If adopted widely, HPV vaccines may prevent 70% of cervical cancers in the United States (Smith et al., 2007; Villa et al., 2006). However, HPV vaccine initiation among eligible females remains low in the United States, with recent estimates of having at least one vaccine dose ranging from 5% to 26% (Centers for Disease Control and Prevention, 2008; Kahn et al., 2008; Rosenthal et al., 2008).

Given that parents likely play a large role in the vaccination behaviors of their adolescent daughters, their beliefs about HPV vaccination are important for vaccine initiation. The associations of parent beliefs and HPV vaccine acceptability and intent to vaccinate have already been studied extensively (Brewer & Fazekas, 2007; Constantine & Jerman, 2007; Dempsey, Zimet, Davis, & Koutsky, 2006; Fazekas, Brewer, & Smith, 2008; Olshen, Woods, Austin, Luskin, & Bauchner, 2005). Since intent does not always translate into health behavior (Johnston & White, 2003; Ravis & Sheeran, 2003), this research needs to be extended to actual vaccine initiation. At this time, only one published study has addressed parent beliefs and HPV vaccine uptake. In this study of 153 parents recruited from a primary care clinic, believing their daughter would not oppose the vaccine regimen was the only parent belief associated with vaccine initiation (Rosenthal et al., 2008).

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The Health Belief Model (HBM) (Becker, 1974) is one of the most widely used theoretical frameworks for understanding health behaviors (Painter, Borba, Hynes, Mays, & Glanz, 2008), including vaccine uptake (Blue & Valley, 2002; Brewer et al., 2007; Brewer & Fazekas, 2007; Chapman & Coups, 1999). HBM constructs have previously been applied to HPV vaccine research (Brewer & Fazekas, 2007). Specifically, perceived risk (or likelihood) is the belief that HPV infection and cervical cancer are likely to occur. Perceived severity is how severe the negative effects of HPV infection and cervical cancer are believed to be. Perceived effectiveness (or benefit) is the belief that HPV vaccine will diminish the risk or severity of HPV infection and cervical cancer. Perceived barriers are any perceived obstacles preventing HPV vaccination. Cues to action are situational factors prompting HPV vaccination, such as a doctor's recommendation.

The current study applied the HBM to identify parent beliefs associated with HPV vaccine initiation. Such beliefs offer modifiable targets for future intervention studies attempting to increase HPV vaccine initiation. Because we believe it is important to study populations where individuals are at high risk of cervical cancer since they stand to benefit the most from widespread coverage of HPV vaccine, we focused on female adolescents from an area with cervical cancer rates well above the United States national rate. Additionally, we aimed to determine if associations differed by race and urban/rural status because these factors are important determinants of cervical cancer mortality (Akers et al., 2007; Newmann & Garner, 2005; Yabroff et al., 2005).

## Methods

### Study design

The Carolina HPV Immunization Measurement and Evaluation (CHIME) Project was designed to investigate HPV vaccine decision making by caregivers for adolescent girls in an area where women are at high risk of cervical cancer. The sampling and data collection methods used for the caregiver study are reported in detail elsewhere (Hughes et al., 2009) and briefly below.

We identified counties in North Carolina that had 1) high rates of invasive cervical cancer (i.e., incidence >10 cases/100,000 women annually from 1993 to 2003 and mortality >4 cases/100,000 women annually from 1994 to 2004) relative to the United States national rate (mean incidence during 1993–2003 = 8.57 cases/100,000 women, mean mortality during 1994–2004 = 2.88 cases/100,000 women (National Cancer Institute, 2008)), 2) 20% or more African American residents, and 3) at least 1500 girls in the targeted age range of 10–18 years (to allow for a minimum number of caregivers). Eleven counties met study inclusion criteria, of which nine (eight rural and one urban) were geographically clustered in the southeast part of the state. After matching the eight rural counties on population size, proportion of African American residents, and rates of cervical cancer, we randomly selected four rural counties to study (Duplin, Harnett, Sampson, and Wayne counties). The one urban county (Cumberland) in this region was also selected.

Trained interviewers contacted a probability sample of households with telephone line access in these five counties. Households were sampled using either random-digit-dialing (5%) or a non-overlapping targeted-list frame of directory-listed residential telephone numbers with available recent household demographic information (95%). We oversampled rural telephone exchanges (U.S. Census Bureau, 2008), households likely to be African American, and households likely to contain a 10–18 year-old female.

Once a household was confirmed to contain a female aged 10–18, consent for a study interview was sought from a caregiver.

Parents, grandparents, or any other individual who self-identified as being responsible for the adolescent's care were considered to be caregivers. Female caregivers were preferred, but male caregivers were interviewed if a female caregiver was unavailable. For the sake of simplicity, we refer to participants as parents for the remainder of this report. If a household contained more than one 10–18 year-old female, interview software randomly selected one as the index child for the interview. Interviewers were intermittently monitored during their calls and evaluated every two weeks to help ensure high data quality.

Interviews were conducted between July and October 2007. We interviewed 73% (889/1220) of parents contacted in eligible households (Hughes et al., 2009). Parents received a ten dollar payment for the phone interview. The study was approved by the Institutional Review Board at the University of North Carolina.

### Measures

#### Vaccine initiation

To ensure that parents had some understanding of HPV, they received the following information: "HPV is a common sexually transmitted infection that sometimes leads to genital warts, abnormal Pap tests, and cervical cancer," and "An HPV vaccine is now available that protects against most genital warts and cervical cancer. Sometimes it's called the cervical cancer vaccine, HPV shot, or Gardasil. I'll call it the HPV vaccine."

Vaccine initiation, the main study outcome, was assessed by asking "Has [name] had any shots of the HPV vaccine?" Response options were "yes," "no," and "don't know" for this item. Because few daughters had received more than one dose of the vaccine, we focus on vaccine initiation of having received at least one dose, although we acknowledge that three doses are required for full vaccine effectiveness.

#### Beliefs

Perceived severity of cervical cancer if their daughters got the disease was assessed using the question "How serious would it be if [name] got cervical cancer?" Perceived likelihood of their daughters getting cervical cancer (conditional on whether or not the daughter had been vaccinated) was examined using "Given that your daughter has been vaccinated against HPV, what is the chance that she will get cervical cancer in the future?" for vaccinated daughters, and "Without the vaccine, what do you think is the chance that [name] will get cervical cancer in the future?" for unvaccinated daughters. Response options were "slightly," "moderately," "very," and "extremely" for perceived severity (coded 1–4, respectively), while perceived likelihood items used "no chance," "low," "moderate," and "high chance" (coded 1–4, respectively). Cues to action examined were having received a doctor's recommendation to get HPV vaccine and reporting a history of cervical cancer or genital warts among the parent or someone they care about.

We assessed perceived vaccine effectiveness (2 items,  $\alpha = 0.64$ , possible range = 1.0–4.0), perceived potential harms of HPV vaccine (6 items,  $\alpha = 0.70$ , possible range = 1.0–4.0), and perceived barriers to getting their daughter HPV vaccine (5 items,  $\alpha = 0.70$ , possible range = 1.0–4.0) using scales developed by McRee et al. (McRee, Brewer, Reiter, Gottlieb, & Smith, working paper). The perceived effectiveness scale addressed the ability of HPV vaccine to prevent cervical cancer and genital warts. The perceived potential harms scale assessed beliefs about vaccine safety and potential adverse events following vaccination. The perceived barriers scale addressed the difficulty of finding a healthcare provider with HPV vaccine available, a healthcare provider where the vaccine was affordable, a healthcare provider that was easy to get to,

a healthcare provider without a long wait to get an appointment, and HPV vaccine cost. For each scale, the mean of the individual items was calculated. Responses were coded such that higher scores indicate a greater level of the relevant construct. A fourth scale developed by McRee et al., assessing uncertainty about HPV vaccine, was not used in our analyses because most items were not asked of parents with vaccinated daughters.

Anticipated regret was examined using the item "Imagine that your daughter became more sexually active earlier than she would have otherwise because she got the HPV vaccine. How much would you regret that she did get the vaccine?" (Ziarnowski, Brewer, & Weber, 2008). Responses options were "not at all," "a little," "a moderate amount," and "a lot" (coded 1–4, respectively). Belief that the daughter's health insurance paid for HPV vaccine was assessed using the item "Does [name]'s insurance cover the HPV vaccine?" Although response options were not offered to parents, responses were coded as "yes," "no," "maybe/don't know."

### Demographics

We collected information on daughter's age as well as parent's age, race, gender, marital status, income, education level, and rural/urban residence. Rural residence was based on United States Census classification for the census block where the respondent was living (U.S. Census Bureau, 2008).

### Statistical analyses

We used bivariate logistic regressions to compare respondents who reported vaccine initiation with those who did not. Belief variables bivariately associated with HPV vaccine initiation ( $p < 0.05$ ) were included in a multivariate logistic regression model to assess the strength of each variable's association with vaccine initiation after controlling for other beliefs. The multivariate model also controlled for demographic variables bivariately associated with vaccine initiation ( $p < 0.10$ ). Demographic factors were examined only as potential confounders in these analyses, as these associations have been reported elsewhere (Gottlieb et al., working paper). While age variables in Table 1 are categorical for descriptive purposes, analyses used continuous age variables.

In exploratory analyses, we addressed whether associations between parent beliefs and vaccine initiation differed for key demographic groups that the study was specifically designed to examine (race and urban/rural residence). For each subgroup, a multivariate logistic regression model composed of the same variables as the multivariate model for the full sample was constructed. Analyses were unweighted and conducted using SPSS 16.0 (Chicago, IL). Statistical tests were two-tailed using a critical alpha of 0.05.

### Results

Of the 889 parents who completed the survey, most were female (94%), non-Hispanic white (70%) or non-Hispanic African American (23%), married (84%), had at least some college education (79%), and reported a household income of \$50,000 or more (63%) (Table 1). Three parents who did not provide HPV vaccine initiation data (responded "don't know" to the vaccine initiation question) were excluded from all further analyses. Few parents reported that their daughter had received any doses of HPV vaccine (12%, 106/886). Daughter's age was the only demographic factor associated with vaccine initiation, with parents of older daughters being more likely to report vaccine initiation ( $p < 0.001$ ). Although parent age and education level were not associated with vaccine initiation using our criterion for statistical significance, they showed borderline associations that identified them as additional

**Table 1**

Demographic characteristics of daughters and parents from North Carolina, USA ( $n = 889$ ).

	<i>n</i> (%)
<b>Daughter characteristic</b>	
Age (years)	
10–12	250 (28.1)
13–15	296 (33.3)
16–18	343 (38.6)
<b>Parent characteristics</b>	
Age (years)	
< 40	245 (27.6)
40+	644 (72.4)
Gender	
Female	835 (93.9)
Male	54 (6.1)
Race	
Non-Hispanic White	624 (70.2)
Non-Hispanic African American	206 (23.2)
Other	59 (6.6)
Marital status	
Married/living as married	750 (84.4)
Other (divorced, widowed, separated, never married)	139 (15.6)
Education	
Some college or more	699 (78.6)
High school or less	190 (21.4)
Annual Income	
Less than \$50,000	288 (32.4)
\$50,000 and Over	560 (63.0)
Not reported	41 (4.6)
Residence type	
Urban	452 (50.8)
Rural	437 (49.2)

covariates, along with daughter's age, for the multivariate model ( $p < 0.10$ ).

Most parents perceived HPV vaccine to be at least moderately effective (mean = 2.51, standard deviation (SD) = 0.63), some barriers to obtaining the vaccine (mean = 1.58, SD = 0.58), and the possibility of harm from vaccination (mean = 2.12, SD = 0.54). A relatively low percentage of parents reported having received a doctor's recommendation to get their daughter HPV vaccine (22%). Twenty-nine percent ( $n = 260$ ) of parents reported a history of cervical cancer and 18% ( $n = 163$ ) reported a history of genital warts among themselves or people they care about.

Most belief variables were associated with vaccine initiation in bivariate analyses (Tables 2 and 3). Parents who perceived higher levels of vaccine effectiveness or had received a doctor's recommendation to get their daughter's HPV vaccine were more likely to report vaccine initiation (all  $p < 0.01$ ). Parents with vaccinated daughters also perceived lower likelihoods of their daughters getting cervical cancer ( $p < 0.01$ ). Parents were less likely to report vaccine initiation if they had higher perceived barriers to obtaining HPV vaccine, perceived more potential harms of HPV vaccine, reported higher levels of anticipated regret if their daughters became more sexually active due to receiving HPV vaccine, or were unsure if their daughter's health insurance covered the vaccine (all  $p < 0.01$ ).

In multivariate analyses (Table 4), vaccine initiation was higher among parents who had received a doctor's recommendation to get their daughter HPV vaccine. Parents who reported vaccine initiation perceived lower likelihoods of their daughters getting cervical cancer. Vaccine initiation was lower among parents who had higher perceived barriers to getting HPV vaccine, perceived more potential harms of the vaccine, or were unsure if their daughter's insurance

**Table 2**  
Frequencies (%) and odds ratios (95% CI) for categorical variables related to HPV vaccine initiation.

	Parents reporting daughters had received one or more doses of HPV vaccine/total parents in category (%)	Bivariate OR (95% CI)
Doctor recommended that daughter get HPV vaccine		
Yes	78/193 (40.4)	16.11 (10.02–25.90)**
No	28/693 (4.0)	ref.
Believe daughter's health insurance covers HPV vaccine		
Yes	89/234 (38.0)	38.60 (18.99–78.47)**
No	8/77 (10.4)	7.29 (2.72–19.52)**
Maybe/Don't know	9/575 (1.6)	ref.
History of cervical cancer in caregiver or someone they care about		
Yes	36/260 (13.8)	1.28 (0.83–1.96)
No	70/626 (11.2)	ref.
History of genital warts in caregiver or someone they care about		
Yes	18/163 (11.0)	0.90 (0.52–1.53)
No	88/723 (12.2)	ref.

Note.  $n = 886$  (data not used for three parents that did not know if their daughters had received HPV vaccine).

HPV = human papillomavirus, OR = odds ratio, CI = confidence interval, ref. = referent group.

\*\* $p < 0.01$

covered the vaccine. A statistically significant difference was not observed in the multivariate model between parents who believed their daughter's insurance covered the vaccine and those who believed the vaccine was not covered ( $p > 0.05$ ).

Results of exploratory subgroup analyses are displayed in Table 4. Because the number of African American parents was relatively small ( $n = 205$ ), the corresponding number who reported HPV vaccine initiation was low ( $n = 23$ ). Thus, the analysis for this racial group should be viewed as being solely descriptive. Among white parents, doctor's recommendation, perceived likelihood of daughters getting cervical cancer, perceived potential harms of HPV vaccine, and belief about insurance coverage were among the strongest correlates of vaccine initiation. Among African American parents, doctor's recommendation and perceived potential harms of HPV vaccine were significant correlates, but perceived barriers to getting HPV vaccine was an additional strong correlate of vaccine initiation. Belief about insurance coverage was excluded from the model for African American parents due to model instability, and therefore could not be examined as a possible correlate.

Among rural parents, doctor's recommendation, perceived likelihood of daughters getting cervical cancer, and perceived potential harms of HPV vaccine were among the strongest correlates of vaccine initiation. Doctor's recommendation, perceived likelihood of daughters getting cervical cancer, and perceived potential harms of the vaccine had strong associations with vaccine initiation among urban parents. Belief about insurance coverage

was strongly correlated with vaccine initiation among both urban and rural parents.

## Discussion

Though dozens of studies have documented correlates of HPV vaccine acceptability (Brewer & Fazekas, 2007), our study is one of the first to examine correlates of vaccine initiation. Our study is unique in being the first to address HPV vaccine initiation in a racially and geographically diverse population at high risk for cervical cancer. Multiple parent beliefs, including HBM constructs, were correlated with HPV vaccine initiation. Exploratory stratified analyses showed that correlates of HPV vaccine initiation were similar between racial groups and regions, but the relative importance may differ between subgroups.

HBM constructs of doctor's recommendation to get HPV vaccine, perceived barriers to vaccination, and perceived potential vaccine harms were among the strongest correlates of vaccine initiation. These results coincide with previous research addressing both uptake of other vaccines and HPV vaccine acceptability. For influenza and hepatitis B vaccination, cues to action (doctor's recommendation) have been associated with greater vaccine initiation (Bigham et al., 2006; Lyn-Cook, Halm, & Wisnivesky, 2007; Shahrabani, Benzion, & Yom, 2009), while higher perceived barriers and concern about vaccine harms have decreased vaccination coverage (Lyn-Cook et al., 2007; de Wit, Vet, Schutten, & van Steenberg, 2005). A recent review of HPV vaccine acceptability research found that believing a physician would recommend the vaccine increased acceptability and perceived barriers, including cost and vaccine safety, lowered acceptability (Brewer & Fazekas, 2007). This body of literature, supported by the results obtained here, suggests HBM is a useful framework for studying vaccination behaviors, including HPV vaccination.

Parents unsure about their daughters' insurance coverage were less likely to report vaccine initiation compared to both parents who believed insurance did cover the vaccine and those who believed it did not cover the vaccine. It is possible that parents unsure of their insurance coverage are more withdrawn from the healthcare system in general, and therefore may be less apt to seek vaccination for their daughters. It is also possible that parents may only decide whether or not to vaccinate after being offered the vaccine by a doctor and subsequently becoming aware of their insurance coverage. Since most parents in this cross-sectional study were unsure of their daughter's insurance coverage, it is difficult to make solid inferences regarding the association between insurance coverage and vaccine initiation.

Parents who got HPV vaccine for their daughters perceived a lower likelihood that their daughters would get cervical cancer. The finding makes sense because getting the vaccine lowers the objective likelihood of getting cervical cancer and, for this reason, should lower perceived likelihood (Brewer, Weinstein, Cuite, &

**Table 3**  
Means (SD) and odds ratios (95% CI) for continuous variables correlated with HPV vaccine initiation.

	Mean (SD)		Bivariate OR (95% CI)
	Daughter not vaccinated	Daughter vaccinated	
Perceived effectiveness of HPV vaccine	2.45 (0.60)	2.98 (0.64)	4.03 (2.86–5.69)**
Perceived barriers to getting daughter HPV vaccine	1.63 (0.59)	1.21 (0.34)	0.12 (0.06–0.23)**
Perceived harms of HPV vaccine	2.19 (0.53)	1.64 (0.35)	0.06 (0.03–0.11)**
Anticipated regret if daughter became more sexually active due to HPV vaccine	2.74 (1.21)	2.04 (1.27)	0.63 (0.53–0.75)**
Perceived likelihood of daughter getting cervical cancer	2.46 (0.68)	2.02 (0.44)	0.30 (0.21–0.44)**
Perceived severity of cervical cancer if daughter got it	3.72 (0.57)	3.70 (0.62)	0.97 (0.69–1.37)

Note.  $n = 886$  (data not used for three parents that did not know if their daughters had received HPV vaccine).

HPV = human papillomavirus, OR = odds ratio, CI = confidence interval.

\*\* $p < 0.01$ .

**Table 4**

Odds ratios (95% CI) for multivariate correlates of HPV vaccine initiation, full sample and stratified by race and urban/rural status.

	Full sample (n = 886)	White (n = 622)	African American (n = 205)	Urban (n = 449)	Rural (n = 437)
Doctor recommended that daughter get HPV vaccine					
Yes	5.59 (2.96–10.58)**	4.30 (1.91–9.71)**	21.33 (4.89–92.98)**	4.02 (1.65–9.82)**	10.26 (3.60–29.25)**
No	ref.	ref.	ref.	ref.	ref.
Believe daughter's health insurance covers HPV vaccine					
Yes	16.23 (7.00–37.60)**	28.37 (10.11–79.62)**	– <sup>a</sup>	14.30 (4.25–48.10)**	16.80 (4.95–57.00)**
No	9.99 (2.90–34.41)**	10.76 (2.47–46.93)**	–	17.67 (3.52–88.61)**	2.70 (0.25–29.26)
Maybe/don't know	ref.	ref.	–	ref.	ref.
Perceived effectiveness of HPV vaccine	1.68 (0.98–2.89)	3.38 (1.56–7.36)**	0.66 (0.23–1.86)	1.68 (0.79–3.55)	1.47 (0.62–3.50)
Perceived barriers to getting daughter HPV vaccine	0.31 (0.14–0.69)**	0.34 (0.13–0.87)*	0.05 (0.00–0.71)*	0.25 (0.08–0.78)*	0.30 (0.08–1.04)
Perceived harms of HPV vaccine	0.12 (0.05–0.29)**	0.05 (0.02–0.19)**	0.18 (0.04–0.84)*	0.10 (0.03–0.33)**	0.11 (0.03–0.48)**
Anticipated regret if daughter became more sexually active due to HPV vaccine	0.84 (0.65–1.09)	0.91 (0.65–1.27)	1.12 (0.68–1.85)	0.99 (0.68–1.43)	0.72 (0.49–1.07)
Perceived likelihood of daughter getting cervical cancer	0.17 (0.09–0.32)**	0.07 (0.02–0.19)**	0.46 (0.20–1.07)	0.20 (0.09–0.44)**	0.16 (0.06–0.43)**

Note. Odds ratios are from multivariate regression models that contained all variables shown in column and controlled for education level of parent, age of parent (continuous variable), and age of daughter (continuous variable). Full sample includes  $n = 886$  (data not used for three parents that did not know if their daughters had received HPV vaccine). Sample sizes include both daughters who were vaccinated and not vaccinated as reported by their parents. HPV = human papillomavirus, OR = odds ratio, CI = confidence interval, ref. = referent group.

\* $p < 0.05$ , \*\* $p < 0.01$ .

<sup>a</sup> Model did not include belief about insurance coverage due to model instability.

Herrington, 2004). In other words, protection from getting the vaccine lowered perceived likelihood. The finding also reflects our use of perceived likelihood questions that reminded parents of whether their daughter was vaccinated. Conditioning risk questions on behavior is a necessary step to yield interpretable findings in cross-sectional studies such as ours, because people expecting to vaccinate may incorporate this expectation into their risk perception unless they are specifically instructed otherwise. Although the HBM stipulates that perceived likelihood motivates vaccine initiation (i.e., the behavior motivation hypothesis) (Brewer et al., 2004), a longitudinal study design is required to test that hypothesis properly.

Neither perceived severity of cervical cancer nor history of cervical disease among parents or people they care about were associated with vaccine initiation. Perceived severity may not have been associated with vaccine initiation simply due to lack of variation in the parents' responses. Almost all parents (96%, data not shown) thought it would be either "extremely" or "very" serious if their daughters got cervical cancer, resulting in high perceived severity scores regardless of vaccination status. The results concerning cervical disease coincide with those of a recent study which did not find an association between mother's history of HPV-related disease and vaccine uptake (Rosenthal et al., 2008).

Exploratory subgroup analyses suggested that many of the beliefs associated with vaccine initiation are consistent between racial groups and urban/rural parents, but the relative importance of these beliefs may vary within each group. For example, perceived barriers to getting their daughters HPV vaccine was among the strongest correlates for urban parents but failed to reach statistical significance among rural parents. Such findings may highlight some of the subtle differences that exist between parents of different races and geographical regions.

Our results have important implications for future HPV vaccine research. Most importantly, the parent beliefs identified here as correlates of vaccine initiation offer modifiable targets for future intervention studies aimed at increasing HPV vaccine initiation. Interventions centered around HBM constructs have improved vaccination coverage for other vaccines (Hawe, McKenzie, & Scurry, 1998). In the context of our findings, it becomes important to design interventions to help overcome perceived barriers and reduce concerns about potential harms of HPV vaccine. Strategies increasing cues to action, specifically recommendations from physicians, would

also likely be beneficial given the strong associations between doctor's recommendation and vaccine initiation found among parents surveyed here. Since guidelines alone have a limited effect on changing physician behavior (Cabana et al., 1999), interventions to increase physician recommendation may be more effective if they promote organizational change (e.g., changes in clinical procedure or infrastructure) and clinical reminder systems. Such strategies have proven effective in improving health behavior (Stone et al., 2002).

While results from the subgroup analyses should be viewed as tentative until confirmed by future research, they suggest that interventions can target many of the same beliefs across the subgroups but also may need to be slightly tailored to maximize effectiveness. For example, interventions to increase HPV vaccine initiation among African American parents may emphasize ways to overcome perceived barriers as one of its main messages, whereas this may be less important among white parents.

Our study has several important strengths including interviewing a large sample of parents who reside in an area with high cervical cancer rates, a sampling scheme that allowed for comparisons between racial and urban/rural groups, and a good response rate. In addition to the cross-sectional nature of the study design, there were some additional limitations worth highlighting. Only parents who had a telephone and spoke English were interviewed. However, few language problems were encountered during recruitment, and most homes in the United States have telephone service (Blumberg & Luke, 2007). The generalizability of the findings to parents living in other areas is not yet known. Finally, although the study offers early insight into correlates of HPV vaccine initiation, we were unable to examine correlates of completing the HPV vaccine series because few female adolescents had received all three doses.

## Conclusions

The findings of the current study suggest that parent beliefs about HPV vaccine are important to vaccination of their daughters. These beliefs offer potentially modifiable targets that could increase HPV vaccination rates, and they may differ in importance between racial groups and regions. While future research utilizing longitudinal data is needed to confirm these findings, the results presented here are important by offering new insight into modifiable determinants of HPV vaccine initiation.

## References

- Akers, A. Y., Newmann, S. J., & Smith, J. S. (2007). Factors underlying disparities in cervical cancer incidence, screening, and treatment in the United States. *Current Problems in Cancer*, 31(3), 157–181.
- Becker, M. H. (1974). The Health Belief Model and personal health behavior. *Health Education Monographs*, 2, 324–473.
- Benard, V. B., Coughlin, S. S., Thompson, T., & Richardson, L. C. (2007). Cervical cancer incidence in the United States by area of residence, 1998, 2001. *Obstetrics and Gynecology*, 110(3), 681–686.
- Bigham, M., Remple, V. P., Pielak, K., McIntyre, C., White, R., & Wu, W. (2006). Uptake and behavioural and attitudinal determinants of immunization in an expanded routine infant hepatitis B vaccination program in British Columbia. *Canadian Journal of Public Health*, 97(2), 90–95.
- Blue, C. L., & Valley, J. M. (2002). Predictors of influenza vaccine. Acceptance among healthy adult workers. *American Association of Occupational Health Nurses Journal*, 50(5), 227–233.
- Blumberg, S. J., & Luke, J. V. (2007). Wireless substitution: early release of estimates from the National Health Interview Survey, January–June 2007. <http://www.cdc.gov/nchs/nhis/htm>.
- Brewer, N. T., Chapman, G. B., Gibbons, F. X., Gerrard, M., McCaul, K. D., & Weinstein, N. D. (2007). Meta-analysis of the relationship between risk perception and health behavior: the example of vaccination. *Health Psychology*, 26(2), 136–145.
- Brewer, N. T., & Fazekas, K. I. (2007). Predictors of HPV vaccine acceptability: a theory-informed, systematic review. *Preventive Medicine*, 45(2–3), 107–114.
- Brewer, N. T., Weinstein, N. D., Cuite, C. L., & Herrington, J. E. (2004). Risk perceptions and their relation to risk behavior. *Annals of Behavioral Medicine*, 27(2), 125–130.
- Cabana, M. D., Rand, C. S., Powe, N. R., Wu, A. W., Wilson, M. H., Abboud, P. A., et al. (1999). Why don't physicians follow clinical practice guidelines? A framework for improvement. *JAMA*, 282(15), 1458–1465.
- Centers for Disease Control and Prevention. (CDC). (2008). Vaccination coverage among adolescents aged 13–17 years—United States, 2007. *MMWR. Morbidity and Mortality Weekly Report*, 57(40), 1100–1103.
- Chapman, G. B., & Coups, E. J. (1999). Predictors of influenza vaccine acceptance among healthy adults. *Preventive Medicine*, 29(4), 249–262.
- Constantine, N. A., & Jerman, P. (2007). Acceptance of human papillomavirus vaccination among Californian parents of daughters: a representative statewide analysis. *Journal of Adolescent Health*, 40(2), 108–115.
- Dempsey, A. F., Zimet, G. D., Davis, R. L., & Koutsky, L. (2006). Factors that are associated with parental acceptance of human papillomavirus vaccines: a randomized intervention study of written information about HPV. *Pediatrics*, 117(5), 1486–1493.
- de Wit, J. B., Vet, R., Schutten, M., & van Steenberg, J. (2005). Social-cognitive determinants of vaccination behavior against hepatitis B: an assessment among men who have sex with men. *Preventive Medicine*, 40(6), 795–802.
- Fazekas, K. I., Brewer, N. T., & Smith, J. S. (2008). HPV vaccine acceptability in a rural Southern area. *Journal of Women's Health*, 17(4), 539–548.
- Gottlieb, S. L., Brewer, N. T., Sternberg, M. R., Smith, J. S., Ziarnowski, K., Liddon, N., et al. (Working Paper). Human papillomavirus vaccine initiation in an area with elevated rates of cervical cancer.
- Hawe, P., McKenzie, N., & Scurry, R. (1998). Randomised controlled trial of the use of a modified postal reminder card on the uptake of measles vaccination. *Archives of Disease in Childhood*, 79(2), 136–140.
- Hughes, J., Cates, J. R., Liddon, N., Smith, J. S., Gottlieb, S. L., & Brewer, N. T. (2009). Disparities in how parents are learning about the human papillomavirus vaccine. *Cancer Epidemiology, Biomarkers & Prevention*, 18(2), 363–372.
- Johnston, K. L., & White, K. M. (2003). Binge-drinking: a test of the role of group norms in the theory of planned behaviour. *Psychology and Health*, 18(1), 63–77.
- Kahn, J. A., Rosenthal, S. L., Jin, Y., Huang, B., Namakydoust, A., & Zimet, G. D. (2008). Rates of human papillomavirus vaccination, attitudes about vaccination, and human papillomavirus prevalence in young women. *Obstetrics and Gynecology*, 111(5), 1103–1110.
- Lyn-Cook, R., Halm, E. A., & Wisnivesky, J. P. (2007). Determinants of adherence to influenza vaccination among inner-city adults with persistent asthma. *Primary Care Respiratory Journal*, 16(4), 229–235.
- McRee, A. L., Brewer, N. T., Reiter, P. L., Gottlieb, S. L., & Smith, J. S. (Working Paper). The Carolina HPV Immunization Attitudes Scale (CHIAS): scale development and associations with intentions to vaccinate.
- Markowitz, L. E., Dunne, E. F., Saraiya, M., Lawson, H. W., Chesson, H., Unger, E. R., et al. (2007). Quadrivalent human papillomavirus vaccine: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR. Recommendations and Reports*, 56(RR-2), 1–24.
- National Cancer Institute. (2008). *Surveillance, Epidemiology, and End Results (SEER) cancer statistics*. <http://seer.cancer.gov/faststats/index.php>.
- Newmann, S. J., & Garner, E. O. (2005). Social inequities along the cervical cancer continuum: a structured review. *Cancer Causes & Control*, 16(1), 63–70.
- Olshen, E., Woods, E. R., Austin, S. B., Luskin, M., & Bauchner, H. (2005). Parental acceptance of the human papillomavirus vaccine. *Journal of Adolescent Health*, 37(3), 248–251.
- Painter, J. E., Borba, C. P., Hynes, M., Mays, D., & Glanz, K. (2008). The use of theory in health behavior research from 2000 to 2005: a systematic review. *Annals of Behavioral Medicine*, 35(3), 358–362.
- Rivis, A., & Sheeran, P. (2003). Social influences and the theory of planned behaviour: evidence for a direct relationship between prototypes and young people's exercise behaviour. *Psychology and Health*, 18(5), 567–583.
- Rosenthal, S. L., Rupp, R., Zimet, G. D., Meza, H. M., Loza, M. L., Short, M. B., et al. (2008). Uptake of HPV vaccine: demographics, sexual history and values, parenting style, and vaccine attitudes. *Journal of Adolescent Health*, 43(3), 239–245.
- Saraiya, M., Ahmed, F., Krishnan, S., Richards, T. B., Unger, E. R., & Lawson, H. W. (2007). Cervical cancer incidence in a prevaccine era in the United States, 1998–2002. *Obstetrics and Gynecology*, 109(2 Pt 1), 360–370.
- Schiffman, M., & Castle, P. E. (2003). Human papillomavirus: epidemiology and public health. *Archives of Pathology & Laboratory Medicine*, 127(8), 930–934.
- Shahrabani, S., Benzion, U., & Yom, D. G. (2009). Factors affecting nurses' decision to get the flu vaccine. *European Journal of Health Economics*, 10(2), 227–231.
- Smith, J. S., Lindsay, L., Hoots, B., Keys, J., Franceschi, S., Winer, R., et al. (2007). Human papillomavirus type distribution in invasive cervical cancer and high-grade cervical lesions: a meta-analysis update. *International Journal of Cancer*, 121(3), 621–632.
- Stone, E. G., Morton, S. C., Hulscher, M. E., Maglione, M. A., Roth, E. A., Grimshaw, J. M., et al. (2002). Interventions that increase use of adult immunization and cancer screening services: a meta-analysis. *Annals of Internal Medicine*, 136(9), 641–651.
- U.S. Census Bureau. (2008). *Census glossary*. [http://factfinder.census.gov/home/en/eps/glossary\\_a.html](http://factfinder.census.gov/home/en/eps/glossary_a.html).
- Villa, L. L., Costa, R. L., Petta, C. A., Andrade, R. P., Paavonen, J., Iversen, O. E., et al. (2006). High sustained efficacy of a prophylactic quadrivalent human papillomavirus types 6/11/16/18 L1 virus-like particle vaccine through 5 years of follow-up. *British Journal of Cancer*, 95(11), 1459–1466.
- Yabroff, K. R., Lawrence, W. F., King, J. C., Mangan, P., Washington, K. S., Yi, B., et al. (2005). Geographic disparities in cervical cancer mortality: what are the roles of risk factor prevalence, screening, and use of recommended treatment? *The Journal of Rural Health*, 21(2), 149–157.
- Ziarnowski, K. L., Brewer, N. T., & Weber, B. (2008). Present choices, future outcomes: anticipated regret and HPV vaccination. *Preventive Medicine*, 48(5), 411–414.