

Provider Communication and Mothers' Willingness to Vaccinate Against HPV and Influenza: A  
Randomized Health Messaging Trial

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**Abstract**

**Objective:** Understand the effect of a health messaging intervention focused on provider communication about vaccination on mothers' willingness to vaccinate children against HPV and seasonal influenza.

**Methods:** 2,476 mothers of 9-13-year-olds in the U.S. completed a Web-based survey in August 2014. Mothers were randomized to one of two groups targeting HPV or influenza vaccine. Mothers whose child had *not* received the target vaccine (i.e., zero doses of HPV vaccine/no prior-year administration of influenza vaccine) were randomized to the intervention. The study used a 3x2 between-subjects design; illustrated vignettes depicted one of three levels of provider recommendation strength (brief mention of vaccination, strong recommendation of vaccination, or personal disclosure of vaccination of own children), and presence or absence of information comparing safety of vaccination to the safety of a common daily activity. Outcome was mothers' willingness to have their child receive the target vaccine (0-100.) Perceived benefits of vaccination were assessed prior to viewing the intervention and included as a covariate in analyses, along with child gender.

**Results:** For HPV vaccine, there was a main effect of safety information,  $F(1,684)=7.99$ ,  $p=.005$ , and perceived benefits of vaccination,  $F(1,684)=221.64$ ,  $p<.001$ ) on mothers' willingness to vaccinate. For influenza, perceived benefits of vaccination significantly related to willingness,  $F(1,462)=105.78$ ,  $p<.001$ ). Child gender was not associated with willingness.

**Conclusions:** Provider communication about vaccination may need to be tailored to the vaccine in question. A next step to increasing coverage for both HPV and influenza vaccines may be an intervention aimed at increasing mothers' perceived benefits of vaccination.

**What's New?**

We found that mothers of non-vaccinated children reported lower willingness to vaccinate against influenza than HPV. Viewing information about the relative safety of vaccination compared to common daily activities increased mothers' willingness to vaccinate against HPV only.

The Advisory Committee on Immunization Practices (ACIP) recommends that the human papillomavirus vaccine be routinely administered to early adolescents (i.e., 11–12-year-olds) in the United States, while influenza (flu) vaccination is recommended annually for children starting at 6 months of age.<sup>1</sup> Healthy People 2020 goals for vaccine coverage include 80% of individuals receiving at least 3 doses of the HPV vaccine by age 13-15, as well as 70% of children aged 6 months through 17 years being vaccinated annually against seasonal flu.<sup>2</sup> Nationwide surveillance data from 2013 indicates that only 37.6% of females and 13.9% of males aged 13-17 had completed the HPV vaccine series in 2013, while 57.3% of females and 34.6% of males had received at least 1 dose of the vaccine.<sup>3</sup> Coverage estimates for the flu vaccine during the 2013-2014 season were 61% for 5-12 year olds and 46% for 13-17 year olds.<sup>4</sup>

Low HPV and flu vaccination rates among adolescents are concerning, given the public health implications of these viruses. Vaccination provides effective protection for males and females against HPV infection,<sup>5</sup> which is the primary cause of cervical cancer and leading cause of other anogenital and oropharyngeal cancers, in addition to causing genital warts.<sup>6</sup> Three HPV vaccines available at the time of the study protect against two HPV types (HPV16 and 18) associated with the majority of HPV-related cancers. The quadrivalent vaccine also protects against HPV6 and HPV11, which are associated with 90% of genital warts. The nine-valent vaccine provides protection against HPV6, HPV11, and five additional oncogenic types.<sup>7</sup>

Annual vaccination is the primary strategy for preventing transmission of seasonal flu. The vaccine is developed annually to target specific flu viruses predicted to be most common during the upcoming season.<sup>8</sup> Flu viruses can lead to mild to severe illness, worsening of other chronic medical conditions, and even death. The flu vaccine can also reduce symptom severity if a vaccinated individual does contract a flu virus.

Healthcare provider recommendation is consistently cited as a primary reason that parents vaccinate or intend to vaccinate their adolescent children.<sup>9-11</sup> Parental health beliefs, such as perceived benefits or side effects of vaccination,<sup>9,12-14</sup> as well as perceived social norms regarding vaccination,<sup>13,15</sup> can either promote or hinder vaccination among adolescents. When parents' health beliefs serve as a barrier to vaccination, recommendation from a healthcare provider may help to modify these beliefs, resulting in vaccine initiation.<sup>16,17</sup>

Given this influence of healthcare provider recommendation, intervention research targeting methods for improving the effectiveness of provider communication with patients and parents about vaccination may be key for increasing vaccine coverage.<sup>9,14,18,19</sup> Strategies may include providing presumptive recommendations for vaccination,<sup>16</sup> addressing parental concerns about the safety of vaccination,<sup>20</sup> or sharing personal experiences with parents (e.g., sharing that they have chosen to vaccinate their own children).<sup>17</sup>

Previous research suggests that viewing health messages about vaccination can affect parents' willingness to vaccinate their children,<sup>21,22</sup> although these messages have not specifically focused on healthcare provider communication. Health messages have typically included information comparing risks from the vaccine-preventable disease to vaccine-related risks (i.e., side effects). To our knowledge, vaccine-related risk information has not been compared to risk of harm from other common childhood activities, such as involvement in youth sports.

The objective of this study was to determine whether mothers' willingness to vaccinate their children against HPV or flu could be affected by viewing health message vignettes depicting an interaction between a healthcare provider and mother. Specifically, we explored whether vignettes depicting varying levels of strength of recommendation by the provider and/or

provider discussion of vaccine safety (i.e., presence/absence of relative safety information about common daily activities, such as sports) increased mothers' willingness to vaccinate their children relative to a brief presumptive recommendation for vaccination by the provider. We also examined whether any effect of viewing the vignettes remained after adjusting for mothers' pre-existing beliefs about the benefits of vaccination.

## Methods

### *Sample + Procedure*

Participants were mothers or female legal guardians of 9-13-year-olds living in the United States. We chose to collect survey data from mothers, as they are more likely than other caregivers to be primary decision makers regarding children's healthcare,<sup>23</sup> and maternal report of HPV vaccination status may be more accurate than reports from other caregivers.<sup>24,25</sup> We targeted mothers of 9-13-year-old males and females, as this includes all children within the targeted age range for routine HPV vaccination (ages 11–12), slightly older children eligible for “catch up” HPV vaccination (age 13), and younger children eligible to receive the HPV vaccine (ages 9–10) prior to the age of routine recommendation. Additionally, rates of flu vaccination begin to decline within this age range.<sup>4</sup>

The study protocol was approved by the institutional review board at Indiana University – Purdue University Indianapolis and granted exempt status. Data were collected in August 2014. Participants were recruited through Survey Sampling International (SSI), a survey research company that maintains a national panel of over 4 million individuals in the United States.<sup>26</sup> Each panel member may participate in up to four surveys annually, and respondents are entered into a lottery to win a monetary prize through SSI. E-mail invitations were sent at random by SSI

to members of SSI's U.S. panel meeting the study's target demographic (i.e., mothers or female legal guardians of a 9-13-year-old child living in their household). Initially, 3,208 panelists responded to the generic e-mail invitation to participate in a survey by clicking the link directing them to the Web-based survey, which was housed on the authors' university server. After being presented with a brief description of the study, 2,860 women (89%) agreed to complete the survey. Of these participants, 26 elected to withdraw from the study throughout the course of the survey; 2,476 of the remaining women met eligibility criteria for participation (i.e., were at least 18 years old and the mother or female legal guardian of at least one 9-13-year-old child). Participants with more than one 9–13-year-old child were prompted to answer questions about their youngest child in this age range. Although the participants were recruited nationally, the sample does not constitute a nationally representative sample.

### *Experimental Design*

All participants provided basic information about their child's HPV and flu vaccination history and were then randomized to either an HPV- or flu-targeted group to receive additional survey items focused on that target vaccine (Figure 1). Following randomization into the targeted vaccine group, participants whose child had *not* received the target vaccine (or no prior-year administration for the flu-targeted group) were presented with basic information on the target vaccine and the medical condition prevented by the target vaccine. They were then randomly assigned with equal allocation to one of six health messaging interventions, based on a 3 x 2 between-subjects factorial design (strength of recommendation x safety information). All randomization occurred using the built-in randomization function with equal presentation to

groups provided by the Qualtrics survey tool used to design the web-based survey (Qualtrics, Provo, UT).

Health messages were presented as illustrated vignettes depicting a female healthcare provider speaking to a mother (Figure 2). Displayed text was individualized to reflect the gender of the participant's child. Participants were first shown the image described above, accompanied by the following text: "Now, please imagine you are at your next appointment with your [son/daughter]'s healthcare provider. During your visit, the provider mentions that your [son/daughter] is due to receive the four vaccines routinely recommended for young adolescents." The introductory vignette was followed by an additional vignette representing one of three levels of strength of provider recommendation for vaccination—brief mention (Figure 2A), strong recommendation (Figure 2B), or strong recommendation plus personal disclosure (Figure 2C, with the 2<sup>nd</sup> panel presented following presentation of the 1<sup>st</sup> panel). The next component of the health messaging intervention consisted of either the presence or absence of information regarding the relative safety of vaccination compared to participation in common youth activities, such as soccer or basketball (Figure 2D).<sup>27-29</sup> The health messages did not focus on a specific vaccine but broadly referred to all four vaccines routinely recommended for adolescents.

### *Measures*

Child's HPV vaccination history was measured using participant report of the number of HPV shots her child had received (i.e., 0–3). Child's flu vaccination history was measured based on participant report of whether the child had received the flu vaccine during the most recent flu season, specified as approximately September 2013-March 2014 (i.e., yes or no). Responses of

“don’t know” regarding vaccine history were treated as missing; those participants were not randomized to receive the health messaging intervention.

Participant beliefs regarding general benefits of vaccination were measured using the following five items with a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree): “It is important that people get vaccinated so that they can protect their health,” “It is safe for a person to get a vaccine,” “If a person gets too many vaccines, it can ruin his/her immune system,” “New vaccines might be unsafe,” and “People don’t need vaccines unless they are currently at risk for getting the disease.” The latter three items were reverse coded so that higher scores on all items reflected stronger beliefs in the benefits of vaccination. The mean of the five items was calculated for use in the analyses (Cronbach’s  $\alpha = .78$ ). The scale has been used previously in research with parents of early adolescents and shown to have predictive validity, in that it correlates with parents’ intent to vaccinate against HPV as well as first-dose acceptance.<sup>12</sup> Mothers’ perceived benefits of vaccination were assessed subsequent to providing information on the child’s vaccination history but prior to viewing the health messaging intervention.

Participants provided sociodemographic information, including participant’s age; child’s age, biological sex, and race/ethnicity; and geographic region of residence, which was determined based on the participant’s reported ZIP code and categorized according to U.S. census region (i.e., south, midwest, west, and northeast).

The primary outcome was participant willingness to have her child receive the target vaccine. Immediately following the messaging intervention, participants responded to the prompt, “How willing would you be to get [child’s name] vaccinated against [HPV/the flu] during this visit, if the vaccine was free and available at the healthcare provider’s office?” using

a response scale ranging from 0 (definitely would not) to 50 (undecided) to 100 (definitely would). Participants indicated their response using a continuous sliding bar scale, with multiples of 10 demarcated as a visual guide. This measure has been used previously to measure parental vaccine acceptability/willingness to vaccinate<sup>30</sup> and reflects how people naturally understand concepts of probability and likelihood. We elected to measure willingness to vaccinate with no cost, as the two target vaccines are available free of charge to most children through the Vaccine for Children Program or under the preventive services requirements of the Affordable Care Act.<sup>31,32</sup>

### *Statistical Analysis*

We first tested for differences in sociodemographic characteristics and vaccine attitudes across the health messaging groups, using Pearson chi-square tests for categorical variables and one-way analysis of variance (ANOVA) for continuous variables. Using analysis of covariance (ANCOVA), we then tested for the main and interactive effects of the two experimental factors (strength of recommendation and presence of relative safety information). Perceived benefits of vaccination and child gender were included as covariates in the model. Effects were analyzed separately by target vaccine group, as we were interested in the effect of the health messaging intervention on willingness to vaccinate, rather than the effect of being randomized into one of the vaccine groups. Analyses were performed using SPSS version 24. For the flu-targeted group, a sample size of 468 (e.g., minimum of 78 participants in each group) provided us with 83.3%, 89.9%, and 83.3% power to detect an effect size of 0.15 for strength of recommendation, presence of relative safety information, and their interaction, respectively. For the HPV-targeted group, a sample size of 684 (e.g., minimum of 114 in each group) provided us with 94.8%,

97.5%, and 94.8% power to detect an effect size of 0.15 for strength of recommendation, presence of relative safety information, and their interaction, respectively.

## Results

The mean age of participants was 38.0 years ( $SD=8.2$ ). Slightly over half (56.7%) of target children were female, with a mean age of 10.6 years ( $SD=1.4$ ). Child race/ethnicity was reported as follows: White, 71.6%; African American, 13.7%; Hispanic or Latino, 12.7%; Asian, 4.8%; American Indian, 2.3%; Native Hawaiian/Pacific Islander, 0.9%; and other, 1.8%. Participants were instructed to select all applicable options. For analyses, race/ethnicity was coded as follows: non-minority, 65.2% (endorsing “White” only), and minority, 34.8% (including any participants endorsing at least one racial or ethnic category other than “White”). Geographic region of residence was reported as follows: South, 37.8%; Midwest, 23.4%; West, 20.7%; and Northeast, 18.2%.

HPV and flu vaccination history were missing for 97 and 89 participants, respectively; 194 and 24 participants provided a response of “don’t know” regarding HPV and flu vaccine history, respectively, and were excluded from the intervention. Among participants providing vaccination history data, 34.9% reported that their child had received at least one dose of the HPV vaccine, and 56.3% reported that their child had received the flu vaccine during the previous flu season.

The mean score for perceived benefits of vaccination was 3.53 ( $SD=0.78$ ; range 1-5), reflecting overall neutral-to-positive beliefs about the benefits of vaccination.

Sample characteristics are shown for the HPV-targeted group (Table 1) and the flu-targeted group (Table 2). Within each target group, data are first presented by vaccination status

and then arranged by the 6 possible health messaging groups into which participants whose child had not received the target vaccine were randomized. For both target groups, participants' sociodemographic characteristics and perceived benefits of vaccination did not differ significantly among the six messaging groups (all  $ps > .05$ ).

Among participants who were randomized to the HPV-targeted group and whose child had not already received at least 1 dose of the HPV vaccine (i.e., 58.5% of randomized participants; see Figure 1), mean willingness to have the child receive the HPV vaccine was 59.7 (SD = 35.4, range 0-100). Among participants randomized to the flu-targeted condition and whose child had not received the flu vaccine during the previous flu season (i.e., 39.8% of randomized participants), mean willingness to have the child receive the flu vaccine was 50.6 (SD=35.9, range 0-100). An independent samples  $t$ -test indicated that this difference in mean willingness between target groups was statistically significant,  $t(1160)=4.26, p<.001$ .

For the HPV-targeted group, ANCOVA results indicated a significant main effect of viewing information regarding the relative safety of vaccination on participants' willingness to vaccinate their child against HPV,  $F(1,684) = 7.992, p = .005$ , partial  $\eta^2=.012$ . This effect is illustrated in Figure 3. Strength of recommendation did not have a significant main effect on participant willingness to vaccinate against HPV, and there were no significant interaction effects between factors. Perceived benefits of vaccination was significantly related to participants' willingness to vaccinate their child against HPV,  $F(1,684) = 221.641 p < .001$ , partial  $\eta^2=.245$ . Child gender was not significantly associated with willingness to vaccinate.

For the flu-targeted group, ANCOVA results indicated no significant main effects of either safety information or strength of recommendation on participant willingness to vaccinate the child against flu. There were no significant interaction effects. Perceived benefits of

vaccination, however, was significantly related to participants' willingness to vaccinate,  $F(1,462) = 105.783, p < .001$ , partial  $\eta^2 = .186$ . Child gender was not significantly associated with willingness to vaccinate.

For each target group, we conducted a sensitivity analysis in which we explored whether pre-existing perceived benefits of vaccination might moderate the effect of health messaging intervention on willingness to vaccinate (i.e., whether the intervention was more or less effective among mothers with varying perceptions of vaccine benefits), rather than including this variable as a continuous covariate, as in the main analyses. In this sensitivity analysis, we categorized participants into three groups based on their perceived benefits of vaccination score: "low" (score  $< 3$ ; 21.2%), "middle" (score  $\geq 3$  and  $< 4$ ; 47.2%), and "high" (score  $\geq 4$ ; 31.6%). The categorical vaccine attitudes variable did not have a significant main effect on participant willingness to vaccinate in either target vaccine group, and there were no significant interactions between vaccine attitudes and the other factors.

We also conducted additional sensitivity analyses in which we explored the potential moderating effect of child age on participant willingness to vaccinate (i.e., whether the intervention was more or less effective depending on the age of the target child). When included as a continuous covariate in the full models described in the main analyses, age was not significantly related to participant willingness to vaccinate in either target group. When included in the full ANCOVA model as an additional categorical factor (dichotomized as "age 9–10" vs. "ages 11–13"), there was no main effect of age group nor any interactive effects between age group and the other factors.

## Discussion

Mothers' willingness to vaccinate differed by target vaccine. Specifically, mothers of non-flu-vaccinated children showed lower overall willingness to receive that vaccine when compared to mothers with non-HPV-vaccinated children and their willingness to receive the HPV vaccine. Mothers of non-HPV-vaccinated children were influenced by viewing health messages presenting relative risk information, as indicated by an increase in willingness to vaccinate. In contrast, the smaller group of mothers of non-flu-vaccinated children were not influenced by the intervention.

Several factors could explain this relative resistance among flu non-vaccinators. The low rate of HPV vaccination relative to influenza vaccination may have provided more opportunity for change in maternal attitude toward HPV vaccination. Flu vaccine is recommended annually to children and adults, and mothers who choose not to vaccinate their children against the flu regularly may routinely refuse the vaccine for themselves or children or perceive more negative effects of the vaccine. In contrast, mothers who have not vaccinated their children against HPV may be less familiar with HPV vaccine and may be more open to vaccination when they do receive information from their health care provider.

In contrast to prior studies highlighting the effect of provider recommendation on parent acceptance of HPV vaccine, we found no effect of strength of provider recommendation on mothers' willingness to vaccinate. This finding may be an artifact of our visual presentation of health messages, while the power of physician recommendation may derive from the face-to-face encounters with a child's personal physician with whom the family has an established relationship.

We also found no effect of viewing a health message in which a physician disclosed that she had vaccinated her own child on mothers' willingness to vaccinate against either vaccine.

Again, this may be a function of the generic message bearer in our health message vs. the potential influence of disclosure in a face-to-face patient encounter. A systematic review of physician disclosure of personal information<sup>33</sup> reported mixed effects, with pediatricians employing self-disclosure more often than adult providers. Physicians seem to believe that personal messages about what they would do for their own children are an effective communication strategy for persuading vaccine-hesitant parents.<sup>17</sup> To our knowledge, this is the first study to examine the impact of physician self-disclosure of personal vaccination practices on parents' willingness to vaccinate.

Observed differences in intervention effects on willingness to vaccinate against the flu compared to HPV suggest that health communication approaches may need to differ by vaccine type. We found that comparing the relative safety of vaccination to the risk of harm from participating in common, everyday youth activities, such as sports, increased mothers' willingness to vaccinate their non-vaccinated children against HPV but not the flu. Most health messages targeting risk perception compare risk of side effects from receiving a vaccine to risks associated with the child getting the disease if he/she remains unvaccinated. To our knowledge, this is the first study to evaluate the impact of providing relative risk information about everyday child experiences on parents' willingness to vaccinate. Parents' inaccurate beliefs about potential side effects may be more entrenched for the flu vaccine (e.g., "people get sick from the flu after getting the flu vaccine") than for HPV vaccine and therefore less malleable when presented with new risk information. In our study, only pre-existing attitudes about the general benefits of vaccination were associated with willingness to vaccinate children against the flu, suggesting that interventions targeting perceived benefits of vaccination may have the most "bang for the buck" when it comes to increasing flu vaccine coverage.

The study has several limitations. Data were not collected from a nationally representative sample; however, sample demographics were comparable to concurrent U.S. census estimates of the distributions of individuals across geographic regions and of racial groups among 9–13-year-olds,<sup>34,35</sup> and the HPV vaccine initiation rate among 13-year-olds in our 2014 sample was similar to coverage estimates for 13-year-olds in the 2014 NIS-Teen sample.<sup>34,36</sup> Our outcome measured willingness to vaccinate, and medical records documenting subsequent vaccination behavior were unavailable, limiting generalizability to real-world vaccination uptake. However, intention research in the behavioral intervention domain can be viewed as an analogue to animal model studies in the biomedical research domain.<sup>37</sup> As such, our study represents an important preliminary step in developing and improving interventions to improve childhood vaccine uptake.

Table 1. Sample characteristics as distributed across health messaging conditions, HPV-targeted group

Measure	Health Messaging Condition								<i>p</i>
	Vaccination Status		No Safety			Safety			
	Not		Brief	Strong	Personal	Brief	Personal		
	Initiated	Initiated	Mention	Rec	Disclosure	Mention	Strong Rec	Disclosure	
	(n=396)	(n=701)	(n=116)	(n=116)	(n=116)	(n=114)	(n=115)	(n=116)	
Child's age, n	396	700	116	116	116	113	115	116	0.599
Mean ± SD	11.0 ± 1.4	10.5 ± 1.4	10.5 ± 1.4	10.4 ± 1.3	10.6 ± 1.3	10.7 ± 1.4	10.4 ± 1.4	10.4 ± 1.3	
Child's gender, n	396	701	116	116	116	114	115	116	0.596
Male, %	35.6%	42.1%	45.7%	44.0%	38.8%	36.0%	42.6%	45.7%	
Female, %	64.4%	57.9%	54.3%	56.0%	61.2%	64.0%	57.4%	54.3%	
Child's race/ethnicity, n	384	686	114	116	114	113	114	115	0.473
Minority race/ethnicity, %	42.4%	28.7%	32.5%	24.1%	25.4%	34.5%	27.2%	28.7%	
Non-minority race/ethnicity, %	57.6%	71.3%	67.5%	75.9%	74.6%	65.5%	72.8%	71.3%	
Mother's age, n	396	701	116	116	116	114	115	116	0.216

Mean $\pm$ SD	37.7 $\pm$ 7.8	39.1 $\pm$ 8.4	38.0 $\pm$ 8.2	38.9 $\pm$ 7.2	40.8 $\pm$ 10.4	38.6 $\pm$ 7.7	39.1 $\pm$ 7.8	39.5 $\pm$ 8.6	
Geographic region, n	386	688	114	116	115	113	114	116	0.532
Northeast, %	22.0%	17.6%	18.4%	17.2%	13.9%	16.8%	21.9%	17.2%	
Midwest, %	24.4%	24.7%	17.5%	28.4%	27.8%	28.3%	21.1%	25.0%	
South, %	33.4%	39.4%	42.1%	36.2%	41.7%	31.9%	43.9%	40.5%	
West, %	20.2%	18.3%	21.9%	18.1%	16.5%	23.0%	13.2%	17.2%	
Perceived benefits of vaccination,									
n	396	701	116	116	116	114	115	116	0.112
Mean $\pm$ SD	3.6 $\pm$ 0.7	3.5 $\pm$ 0.8	3.4 $\pm$ 0.9	3.7 $\pm$ 0.8	3.4 $\pm$ 0.8	3.5 $\pm$ 0.8	3.5 $\pm$ 0.8	3.5 $\pm$ 0.8	

Table 2. Sample characteristics as distributed across health messaging conditions, influenza-targeted group

	Health Messaging Condition								<i>p</i>
	Vaccination Status		No Safety			Safety			
	Received (n = 699)	Did not Receive (n = 475)	Brief Mention (n = 78)	Strong Rec (n = 79)	Personal Disclosure (n = 78)	Brief Mention (n = 79)	Strong Rec (n = 79)	Personal Disclosure (n = 79)	
Child's age, n	698	474	78	79	77	79	79	79	0.414
Mean ± SD	10.6 ± 1.4	10.6 ± 1.4	10.5 ± 1.3	10.6 ± 1.4	10.8 ± 1.4	10.8 ± 1.5	10.7 ± 1.5	10.4 ± 1.2	
Child's gender, n	699	475	78	79	78	79	79	79	0.149
Male, %	42.8%	50.1%	43.6%	55.7%	57.7%	50.6%	39.2%	53.2%	
Female, %	57.2%	49.9%	56.4%	44.3%	42.3%	49.4%	60.8%	46.8%	
Child's race/ethnicity, n	690	463	77	77	77	78	76	78	0.889
Minority race/ethnicity, %	39.0%	29.2%	32.5%	27.3%	26.0%	28.2%	27.6%	33.3%	
Non-minority race/ethnicity, %	61.0%	70.8%	67.5%	72.7%	74.0%	71.8%	72.4%	66.7%	
Mother's age, n	475	699	78	79	78	79	79	79	0.815
Mean ± SD	37.5 ± 8.6	37.8 ± 7.7	37.6 ± 8.3	37.9 ± 7.1	37.4 ± 7.4	38.9 ± 7.7	38.0 ± 8.9	37.2 ± 6.6	
Geographic region, n	691	464	77	78	77	78	77	77	0.943
Northeast, %	19.8%	13.8%	15.6%	12.8%	14.3%	17.9%	10.4%	11.7%	

Midwest, %	18.4%	27.2%	27.3%	33.3%	27.3%	20.5%	31.2%	23.4%	
South, %	39.4%	37.1%	32.5%	35.9%	37.7%	39.7%	35.1%	41.6%	
West, %	22.1%	22.0%	24.7%	17.9%	20.8%	21.8%	23.4%	23.4%	
Perceived benefits of vaccination, n	699	475	78	79	78	79	79	79	0.879
Mean $\pm$ SD	3.7 $\pm$ 0.7	3.3 $\pm$ 0.8	3.3 $\pm$ 0.8	3.2 $\pm$ 0.9	3.4 $\pm$ 0.8	3.3 $\pm$ 0.8	3.4 $\pm$ 0.8	3.3 $\pm$ 0.8	

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Figure 1. Enrollment, allocation to target group, randomization to intervention, and analysis.

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Figure 2. Vignettes presented as part of health messaging intervention. A, Brief mention vignette. B, Strong recommendation vignette. C, Personal disclosure vignette. D, Relative safety vignette. Text was individualized based on the gender of the target child; vignettes shown are for target daughters.

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Figure 3. Reported willingness to vaccinate child against HPV on a scale of 0–100 among mothers in the HPV-targeted group, by presence of relative safety information about vaccination. Mean scores shown, with error bars representing  $\pm 1$  SE.

## References

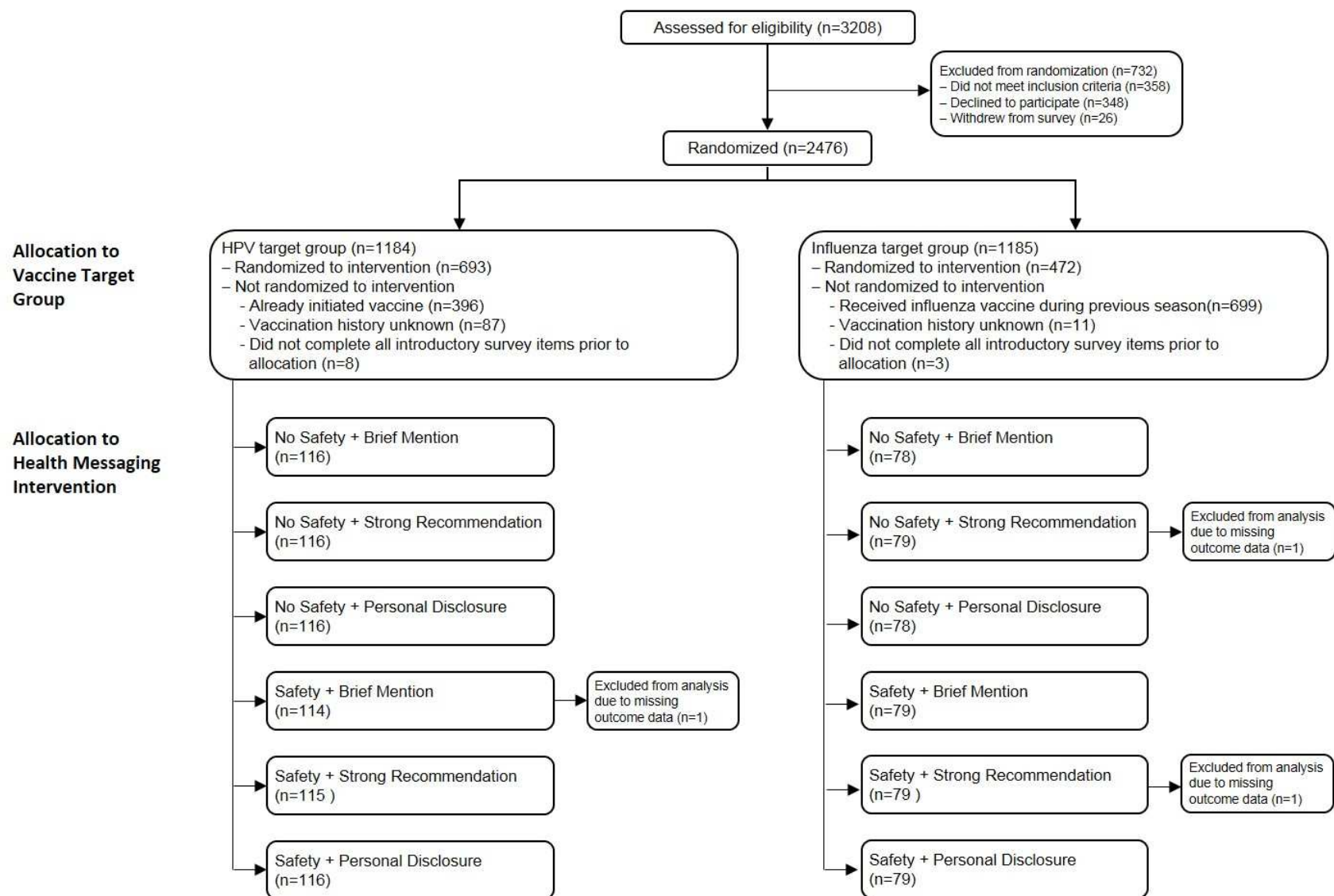
1. Centers for Disease Control & Prevention. General Recommendations on Immunization Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR*. 2011;60(RR02):1-60.
2. U.S. Department of Health and Human Services - Office of Disease Prevention and Health Promotion. Healthy People 2020. <http://www.healthypeople.gov/2020/topics-objectives/topic/immunization-and-infectious-diseases/objectives>. Accessed November 14, 2014.
3. Elam-Evans LD, Yankey D, Jeyarajah J, et al. National, Regional, State, and Selected Local Area Vaccination Coverage Among Adolescents Aged 13-17 Years: United States, 2013. *MMWR Morb Mortal Wkly Rep*. 2014;63(29):625-633.
4. Santibanez TA, O'Halloran A, Zhai Y, et al. Flu Vaccination Coverage, United States, 2013-14 Influenza Season. 2014; <http://www.cdc.gov/flu/fluview/coverage-1314estimates.htm>. Accessed March 3, 2015.
5. Drolet M, Bénard É, Boily M-C, et al. Population-level impact and herd effects following human papillomavirus vaccination programmes: a systematic review and meta-analysis. *The Lancet Infectious Diseases*. 2015;15(5):565-580.
6. Forman D, de Martel C, Lacey CJ, et al. Global burden of human papillomavirus and related diseases. *Vaccine*. 2012;30:F12-F23.
7. Petrosky E, Bocchini Jr JA, Hariri S, et al. Use of 9-valent human papillomavirus (HPV) vaccine: updated HPV vaccination recommendations of the Advisory Committee on Immunization Practices. *MMWR*. 2015;64:300-304.

8. Centers for Disease Control & Prevention. Key Facts about Seasonal Flu Vaccine. 2014; <http://www.cdc.gov/flu/protect/keyfacts.htm>. Accessed June 23, 2015.
9. Gargano LM, Herbert NL, Painter2 JE, et al. Impact of a physician recommendation and parental immunization attitudes on receipt or intention to receive adolescent vaccines. *Human vaccines & immunotherapeutics*. 2013;9(12):2627-2633.
10. Holman DM, Benard V, Roland KB, Watson M, Liddon N, Stokley S. Barriers to human papillomavirus vaccination among US adolescents: A systematic review of the literature. *JAMA pediatrics*. 2013:E1-E7.
11. Flood EM, Rousculp MD, Ryan KJ, et al. Parents' decision-making regarding vaccinating their children against influenza: A web-based survey. *Clinical therapeutics*. 2010;32(8):1448-1467.
12. Rickert VI, Auslander BA, Cox DS, et al. School-based vaccination of young US males: Impact of health beliefs on intent and first dose acceptance. *Vaccine*. 2014;32(17):1982-1987.
13. Sturm LA, Mays RM, Zimet GD. Parental beliefs and decision making about child and adolescent immunization: from polio to sexually transmitted infections. *Journal of Developmental & Behavioral Pediatrics*. 2005;26(6):441-452.
14. Zimet GD, Rosberger Z, Fisher WA, Perez S, Stupiansky NW. Beliefs, behaviors and HPV vaccine: Correcting the myths and the misinformation. *Preventive Medicine*. 2013;57:414-418.
15. Schuler CL, Coyne-Beasley T. Has Their Son Been Vaccinated? Beliefs About Other Parents Matter for Human Papillomavirus Vaccine. *American Journal of Men's Health*. 2015.

16. Opel DJ, Heritage J, Taylor JA, et al. The architecture of provider-parent vaccine discussions at health supervision visits. *Pediatrics*. 2013;132(6):1037-1046.
17. Kempe A, Daley MF, McCauley MM, et al. Prevalence of parental concerns about childhood vaccines: the experience of primary care physicians. *American Journal of Preventive Medicine*. 2011;40(5):548-555.
18. Gilkey MB, Moss JL, Coyne-Beasley T, Hall ME, Shah PD, Brewer NT. Physician communication about adolescent vaccination: How is human papillomavirus vaccine different? *Preventive medicine*. 2015;77:181-185.
19. Nicolai LM, Hansen CE, Credle M, Shapiro ED. Parents' recall and reflections on experiences related to HPV vaccination for their children. *Qualitative Health Research*. 2016;26(6):842-850.
20. Dempsey AF, Zimet GD, Davis RL, Koutsky L. Factors that are associated with parental acceptance of human papillomavirus vaccines: a randomized intervention study of written information about HPV. *Pediatrics*. 2006;117(5):1486-1493.
21. Cox D, Sturm L, Cox AD. Effectiveness of asking anticipated regret in increasing HPV vaccination intention in mothers. *Health Psychology*. 2014;33(9):1074.
22. Fu LY, Bonhomme L-A, Cooper SC, Joseph JG, Zimet GD. Educational interventions to increase HPV vaccination acceptance: A systematic review. *Vaccine*. 2014;32(17):1901-1920.
23. Kaiser Family Foundation. Women, work and family health: a balancing act. 2003; [http://www.kdheks.gov/hcf/healthquest/download/resource\\_downloads/Balancing\\_Act\\_Issue\\_Brief.pdf](http://www.kdheks.gov/hcf/healthquest/download/resource_downloads/Balancing_Act_Issue_Brief.pdf).

24. Ojha RP, Tota JE, Offutt-Powell TN, Klosky JL, Ashokkumar R, Gurney JG. The accuracy of human papillomavirus vaccination status based on adult proxy recall or household immunization records for adolescent females in the United States: results from the National Immunization Survey-Teen. *Annals of epidemiology*. 2013;23(5):281-285.
25. Attanasio L, McAlpine D. Accuracy of Parental Reports of Children's HPV Vaccine Status: Implications for Estimates of Disparities, 2009-2010. *Public Health Reports*. 2014;129(3):237-244.
26. Survey Sampling International. SSI Global Panel Book by Country. 2014; <https://www.surveysampling.com/ssi-media/Corporate/2014%20assets/Global-Panel-Book-2014.image>.
27. Markowitz LE, Dunne EF, Saraiya M, et al. Human Papillomavirus Vaccination: Recommendations of the Advisory Committee on Immunization Practices. 2014; <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr6305a1.htm>. Accessed October 4, 2016.
28. Centers for Disease Control & Prevention. Flu Vaccine Safety Information. 2016; <http://www.cdc.gov/flu/protect/vaccine/general.htm>. Accessed October 4, 2016.
29. Johns Hopkins Medicine. Sports Injury Statistics. [http://www.hopkinsmedicine.org/healthlibrary/conditions/pediatrics/sports\\_injury\\_statistics\\_90,p02787/](http://www.hopkinsmedicine.org/healthlibrary/conditions/pediatrics/sports_injury_statistics_90,p02787/). Accessed October 4, 2016.
30. Donahue KL, Stupianksy NW, Alexander AB, Zimet GD. Acceptability of the human papillomavirus vaccine and reasons for non-vaccination among parents of adolescent sons. *Vaccine*. 2014;32:3883–3885.

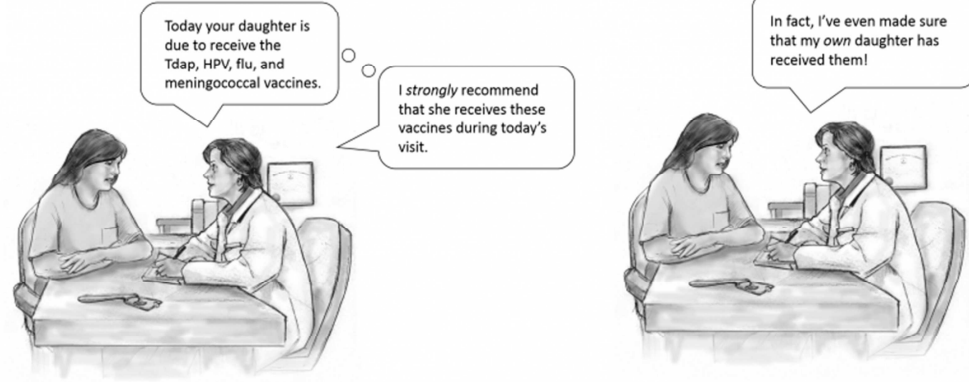
31. Kaiser Family Foundation. Preventive Services Covered by Private Health Plans under the Affordable Care Act. 2014; <http://kff.org/health-reform/fact-sheet/preventive-services-covered-by-private-health-plans/>, May 5, 2015.
32. Centers for Disease Control & Prevention. Vaccines for Children Program. 2014; <http://www.cdc.gov/vaccines/programs/vfc/about/index.html>, May 5, 2015.
33. Arroll B, Allen E-CF. To self-disclose or not self-disclose? A systematic review of clinical self-disclosure in primary care. *British Journal of General Practice*. 2015;65(638):e609-e616.
34. Donahue KL, Hendrix KS, Sturm LA, Zimet GD. Human papillomavirus vaccine initiation among 9–13-year-olds in the United States. *Preventive medicine reports*. 2015;2:892-898.
35. U.S. Census Bureau. Annual Estimates of the Resident Population by Sex, Single Year of Age, Race Alone or in Combination, and Hispanic Origin for the United States: April 1, 2010 to July 1, 2013 - 2013 Population Estimates; generated by K. Donahue using American FactFinder.
36. Reagan-Steiner S, Yankey D, Jeyarajah J, et al. National, regional, state, and selected local area vaccination coverage among adolescents aged 13–17 years—United States, 2014. *MMWR Morb Mortal Wkly Rep*. 2015;64(29):784-792.
37. Stupiansky N, Zimet G. STD vaccine acceptability in sexually transmitted diseases. In: Stanberry LR, Rosenthal SL, eds. *Sexually Transmitted Diseases*. 2 ed. London: Academic Press; 2013:251-269.



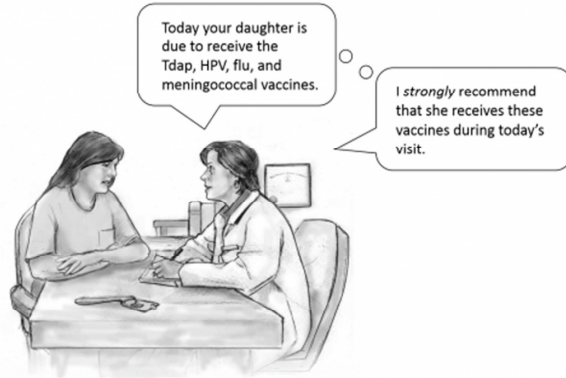
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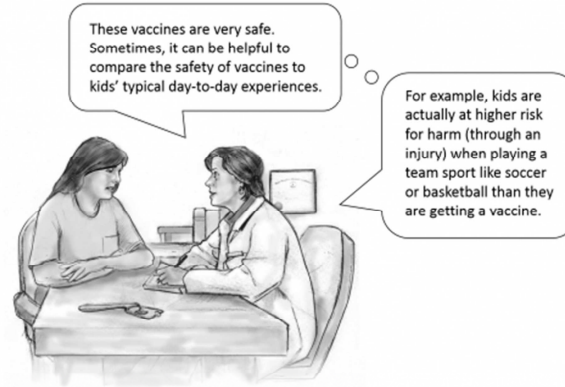
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