HHS Public Access

Author manuscript

Vaccine. Author manuscript; available in PMC 2015 April 01.

Published in final edited form as:

Vaccine. 2014 April 1; 32(16): 1841–1847. doi:10.1016/j.vaccine.2014.01.075.

Factors associated with influenza vaccine receipt in community dwelling adults and their children

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Abstract

Background—Factors associated with influenza vaccine receipt are well studied in healthcare personnel, pregnant women, and the elderly. There has been substantially less research in community dwelling adults and children, and none among entire households. Many studies determine vaccination status by self-report or behavioral intention, outcomes susceptible to misclassification. Given that vaccine is recommended for everyone over six months, re-evaluating these factors is warranted.

Methods—The Household Influenza Vaccine Effectiveness (HIVE) study is a prospective cohort of households with children. In 2010-2011, 549 adults representing 312 households completed surveys evaluating knowledge, attitudes, and practices regarding influenza vaccination for themselves and their children. Using the health belief model (HBM) as a framework, we examined factors associated with documented seasonal influenza vaccine receipt using log-binomial regression models.

Results—In multivariate models, cues to action such as doctor recommendation, (RR 1.62, 95% CI:1.25-2.10), perceived benefits (RR 1.25, 95% CI:1.04-1.50), and perceived susceptibility (RR 1.21, 95% CI:1.03-1.42) were significantly associated with increased likelihood of vaccine receipt among adults while high perceived barriers were associated with decreased likelihood (RR 0.38, 95% CI:0.25-0.59). Similarly, parents reporting higher barriers were less likely (RR 0.58, 95% CI: 0.42-0.79) and those perceiving greater benefits (RR 4.16, 95% CI:2.28-7.59) and severity (RR

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Author Contributions: REM, SEO, JGP, ASM contributed to the conception and design, acquisition of data, and analysis and interpretation of data; REM, SEO, JGP, MGT, AEA, ASM drafted the article or revised it critically for important intellectual content and provided final approval of the version to be submitted

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1.13, 95% CI:1.00-1.27 were more likely to vaccinate their children. The observed effects of perceptions of susceptibility, severity, and benefits were more pronounced at low cues to action for children, as were the effects of perceptions of barriers and severity among adults.

Conclusion—Perceived benefits and barriers are most strongly associated with vaccine receipt. However, the effects of various factors were most pronounced in the absence of cues to action, which may be an important component of targeted interventions.

Keywords

Influenza vaccination; Household vaccination; Attitudes

Background

Seasonal outbreaks of influenza cause substantial morbidity and mortality each year. Influenza vaccine is widely recognized as the first line of defense against infection and is moderately effective [1-3]. Beginning in 2010, the Advisory Committee on Immunization Practices (ACIP) recommended that all persons over 6 months of age in the United States receive an influenza vaccine annually [4]. Despite this essentially universal recommendation, 2010-2011 nationwide coverage estimates for children (51%) and adults (40%) [5] were well below the Healthy People Initiative's goal of 80% [6]. Understanding the decision-making process regarding influenza vaccination is key to improving coverage in the general public.

Factors associated with vaccine receipt have been extensively studied among healthcare personnel (HCP). Previous vaccine receipt, perceived effectiveness, and convenience have all been associated with vaccination [7-10]; with self-protection identified as the primary motivation [11]. Recently, vaccine uptake has been studied in specific populations of community-dwelling children and adults, such as those at higher risk for influenza [9-16]. These studies have reported associations linking vaccine uptake with doctor recommendation [12-14]. Perceived risk of influenza, and perceived safety and effectiveness of the vaccine were associated with an increased intention to have children vaccinated [15]. Yi and colleagues also found that vaccinated adults had higher perceived risk, underlying high-risk conditions, and reported prior influenza vaccine receipt [16].

The Health Belief Model (HBM) includes five constructs that influence health behaviors: perceptions of susceptibility, severity, barriers, benefits, and cues to action [17]. Using a theoretical framework derived from the HBM, we surveyed adult participants in the Household Influenza Vaccine Effectiveness (HIVE) Study. The primary objective was to use this framework (Figure 1) to examine factors associated with documented influenza vaccine receipt in adults and children living in the same household. In addition, we evaluated potential effect modification by cues to action, specifically, external motivators such as family and doctor recommendation that may spur an individual to get vaccinated.

Methods

Participants

The HIVE study is an ongoing prospective cohort study of households with children residing in and around Ann Arbor, MI. Eligibility, recruitment and enrollment procedures have been described previously [18, 19]. Briefly, for the 2010-2011 study period, households with four or more individuals and at least two children who received care from the University of Michigan Health System (UMHS) attended enrollment interviews during which adults provided written informed consent for participation and electronic medical record (EMR) review for themselves and their children; children older than seven provided oral assent. In 2010-2011, 328 households and 1441 individuals participated; 602 (42%) were adults and 839 (58%) were children younger than 18 years. The institutional review board at the University of Michigan Medical School approved this study.

Predictor variables and potential confounders

Surveys were adapted from research conducted during the 2009 H1N1 pandemic to examine the facilitators and barriers to receipt of the monovalent vaccine [20, 21]. Surveys were distributed in the fall of 2010 using online software (Qualtrics, Provo, UT); paper copies were available upon request. Adult household members were queried about the factors influencing their decisions regarding the receipt of seasonal influenza vaccine for themselves and their children. In addition, they reported their perception of the likelihood of specific outcomes of the current season's influenza outbreak including the occurrence of any illness, a severe illness, and the impact on the health care system or community (i.e. overcrowded hospitals, school closures). Survey question wording and response scales are described in Table 1. Covariates significantly associated with predictors and the outcome, or previously established associations [12, 13, 15, 22], were considered in adjusted statistical models. Age and sex were reported at enrollment, adults self-reported education and occupation (including HCP status) and medical conditions considered high-risk for complications of influenza [4] were identified by medical record review.

Individual survey items were grouped into their respective HBM constructs according to the theoretical framework (see Table 1). Items were rated on either a 5-point Likert-scale (Unlikely to Likely) or a 3-level influence scale (not a reason, minor reason, major reason). The Likert-scale items were converted to 3-levels so that all items were associated with a similar scale of 1 (unlikely or not a reason), 2 (uncertain or minor reason), or 3 (likely or major reason). Responses were coded such that higher values of a specific item represented a higher level of the corresponding HBM construct, and were reverse coded when necessary (e.g. "I never get influenza" was reverse coded to represent higher levels of perceived susceptibility). Adult responses were assigned to children in households with at least one completed survey based on responses to the question "Who decides whether or not children less than 18 years old in your household get an influenza vaccine?" If more than one adult reported involvement, an average of the responses was calculated and assigned to each child.

Individual survey items, or the average for children with multiple adult responses, were summed to create scores for each component of the framework (Table 1). In order to

facilitate interpretation, the distribution of each score was examined to determine appropriate cut points and categorized accordingly. Perceived barriers and cues to action were split into tertiles and perceived benefits, susceptibility, and severity were split at the median value.

Outcome - Vaccination Status

The primary outcome was documented receipt of at least one seasonal influenza vaccine between August 2010 and March 2011. Documentation was determined by examining the EMR and/or the Michigan Care Improvement Registry for evidence of vaccine receipt.

Statistical Analysis

Mean response values for individual survey items were calculated by vaccination status, and compared using a two-sample t-test. A higher mean response value corresponded to greater perceived likelihood of an event or greater importance of that factor in the vaccination decision. Framework components were categorized as described and examined in log-binomial regression models to estimate the associations between individual components and documented vaccine receipt [23]. The lowest category of each factor was used as the referent group. Partially adjusted multivariate models controlled for variables that were associated with both vaccination and attitudes about vaccine (age, sex, high-risk condition, health care worker status, education). Fully adjusted multivariate models considered the influence of all other constructs on the association between each individual construct and vaccine receipt. All models considered clustering of subjects in the same household using robust standard error or “sandwich variance estimates” [24]. To evaluate potential effect modification by cues to action we included a product term in partially adjusted models; results were subsequently stratified by levels of the effect modifier.

All statistical analyses were conducted using SAS (release 9.2, SAS Institute) software. A *P*-value <.05 was considered to indicate statistical significance.

Results

Characteristics

Characteristics of the adult survey respondents and the children in their household are presented in Table 2; 549 (92%) adults from 312 (95%) households completed the fall survey. Survey responses for those who reported involvement in the vaccination decision for children resulted in knowledge, attitudes, and practices recorded for 778 children (93%). Documented evidence of receipt of at least one dose of 2010-2011 seasonal influenza vaccine was found in 54% of adults and 66% of of children, respectively. Household educational attainment was high, 85% of adult respondents had graduated from college and 89% of children had at least one parent who had graduated from college. Eleven percent of adults and 10% of children had one or more medical record confirmed high-risk conditions. Eighteen percent of adults reported that they were HCPs, and 24% of children had at least one parent that reported working in health care.

Factors associated with vaccination

Among adults with documented receipt of influenza vaccine, the most commonly reported major factors influencing the decision to get vaccinated were health care provider recommendation (cue to action) (47%), and two “perceived benefit” items: living or working with high-risk individuals (44%), and wanting to lower their own risk of disease (90%). Parents reported doctor recommendation (53%) and lowering risk (95%) as major factors in favor of vaccinating their children.

Among unvaccinated adults and parents of unvaccinated children, low perceived susceptibility (57% and 51%, respectively) was commonly cited as a major factor influencing the vaccination decision. Additionally, concern about vaccine safety was more commonly cited as a major factor among parents who chose not to vaccinate (18%) than among those who vaccinated their children (3%).

Survey items were grouped according to the theoretical framework and the mean responses presented by vaccination status in Table 1. Mean responses to survey items among vaccinated adults and parents of vaccinated children were higher, indicating greater influence on the vaccination decision, for cues to action such as doctor and family recommendation. Likewise, vaccination was associated with higher mean responses for perceived benefits such as lowering one’s risk of infection or protecting those at high risk. Vaccinated adults and parents of vaccinated children had lower perceptions of barriers such as a belief that the vaccine is ineffective or unsafe.

Health Belief Model Constructs and Vaccination

In unadjusted models, those reporting higher perceptions of susceptibility, benefits and cues to action were significantly more likely to have documented receipt of the 2010-2011 seasonal influenza vaccine than those reporting the lowest levels (Table 3). In addition, moderate and high perceived barriers were significantly associated with decreased likelihood of vaccine receipt in both adults and children.

Partially adjusted models that controlled for age, sex, high-risk condition, education and HCP status showed similar results. Significant associations were observed for perceptions of susceptibility, benefits, barriers and cues to action. In fully adjusted models that also controlled for the other HBM constructs, the observed associations were attenuated. Nevertheless, after adjusting for participant characteristics and shared variance with other HBM components, high levels of perceived benefits, susceptibility, and cues to action remained significantly associated with increased likelihood of vaccination among adults. Children whose parents reported high levels of perceived benefits and severity were more likely to be vaccinated independent of participant characteristics and other components. The highest levels of perceived barriers also remained independently associated with decreased likelihood of vaccination. The results of unadjusted, partially adjusted, and fully adjusted models are presented in Table 3.

Effect Modification

We evaluated cues to action as a potential modifier of the associations between the other framework components and vaccine receipt. Significant effect modification by cues to action (p for interaction term < 0.05) was observed for the associations between vaccination and all additional factors among both adults and children (Table 4) in partially adjusted models. To assess this further, we examined the proportion vaccinated by level of each factor, further stratified by cues to action (Figure 2). The effects of perceptions of barriers and severity for adults, and perceptions of benefits, susceptibility, and severity for children all appeared to be modified by cues to action based on the variable slopes of lines connecting data points at each level.

To illustrate, among adults reporting low levels of cues to action, 52% of those with low levels of perceived barriers received vaccine compared to 5% vaccinated among those with high levels of perceived barriers. In contrast, among the strata with high levels of cues to action, the percentage vaccinated did not differ for those with low perceived barriers (69%) versus those with high perceived barriers (64%). In addition, at moderate and high levels of cues to action, perceived severity had little or no association with vaccine receipt, while at the lowest level of cues to action the proportion vaccinated increased from 24% to 38% with increased perceptions of severity.

Among adults, similar slopes of all lines representing stratified perceptions of susceptibility and benefits indicate that the unadjusted effect of those factors may not be modified by cues to action. Among parents with low levels of cues to action and low perceived susceptibility, 23% of children were vaccinated compared to 67% vaccinated among those with high perceived susceptibility. However, at high levels of cues to action, there appears to be no association with vaccination (80% and 71% vaccinated among low and high perceived susceptibility, respectively). A similar trend was observed for perceived severity in children; the strongest associations were among parents with low cues to action.

In terms of perceived benefits, the greatest change in proportion vaccinated between those with low and high perceptions was observed for adults and parents of children with low levels of cues to action. Modification of the association between perceived barriers and vaccination of children appeared less dramatic than among adults.

Table 4 presents the results of partially adjusted multivariate log-binomial regression models stratified by level of cues to action. Among adults, high perceived barriers was significantly associated with decreased likelihood of vaccination at low and moderate levels of cues to action, but not if cues to action were high. Among children, the effects of perceptions of susceptibility, severity, and benefits were all significant among parents with low cues to action, but these effects were reduced for those with moderate cues to action and were no longer significant with high cues to action.

Discussion

Previous studies of influenza vaccine uptake have focused on HCP [12, 22], young children [13, 14], or high-risk individuals [25-27]. Given the current, nearly universal

recommendation for seasonal influenza vaccination, understanding factors associated with vaccine receipt in community dwelling adults and children of all ages is critical. The HIVE study provided a unique opportunity to examine knowledge, attitudes and practices regarding influenza prevention strategies in this population in the context of a household. In addition, as a prospective cohort study of influenza vaccine effectiveness our study documented influenza vaccine receipt using two sources rather than relying on self-report or intent to vaccinate.

Consistent with findings based on self-reported vaccination or intention, we found that perception of benefits, barriers, and cues to action were associated with documented receipt of influenza vaccine during the 2010-2011 season [12-15]. Specifically, we detected a very strong association between parental perception of the benefits of vaccination and the decision to vaccinate their children. We also observed, among adults who reported a high level of barriers, a substantially reduced likelihood of vaccination for both themselves and their children. These results indicate that educational campaigns directed at the public may be best served by addressing these content areas. Smaller associations were observed for perception of benefits, barriers, and cues to action in models that controlled for the other attitudes, suggesting that the components of the health belief model had overlapping information. However, significant associations remain after adjustment for the overlap indicating that there are independent associations between vaccination and perception of benefits, barriers, and cues to action.

Doctor and family recommendation have been previously shown to influence vaccine uptake [12-14]. We demonstrated not only that these factors were associated with vaccination in adults and their children, but also that the effect of other health belief model constructs were modified by cues to action. Specifically, among adults, we found that the reduction in likelihood of vaccination due to perceived barriers disappeared at the highest levels of cues to action. In other words, it appears that external motivating factors such as doctor or family recommendation may be able to overcome the negative influence of concerns about safety or effectiveness on the decision to be vaccinated against influenza. This finding is consistent with observations that doctor recommendation was associated with parental perceptions of safety [28] and implies that intervention strategies that focus on increasing external motivation for adult patients with these types of concerns may be particularly effective. In addition, among parents who report low levels of cues to action we found that perceptions of susceptibility and benefits were more strongly associated with vaccinating their children than among their counterparts with higher levels of cues to action. Therefore, targeting parents with public health messages that may increase perceptions of susceptibility and severity of influenza, and perceived benefits of vaccine may result in better returns in terms of increasing vaccine uptake.

The influenza vaccine has become much easier to obtain outside of the traditional health care delivery system in recent years. As a result, documenting vaccination status is not immune to misclassification. However, this outcome is less likely to be misclassified than self or parental report or behavioral intention [7, 10, 16, 22, 25, 29-31]. The HIVE cohort has a high level of educational attainment and is predominately white non-hispanic; both are associated with higher levels of vaccination [12, 32]. In addition, approximately 60% of the

HIVE cohort received vaccine during the 2010-2011 season [18]. These demographic characteristics are representative of the region from which the population was drawn, nevertheless, our ability to generalize these results to external populations may be limited.

The use of a well-established theoretical framework is a major strength of this analysis. This particular framework describes the proposed associations between the components of the health belief model and influenza vaccination for the current season only. Importantly, these attitudes do not exist independently of previous experiences. Rather, they are likely associated with vaccination history in interesting and complicated ways. In addition, prior season vaccination status is often a major predictor of vaccine receipt in the current season [7-10]. As a result, not controlling for prior season vaccination status may lead to biased effect estimates. However, the association with prior vaccination may be a feedback loop whereby attitudes influence vaccine decision in one year, subsequent experiences with adverse events or infection lead to potential changes in those same attitudes which in turn are associated with receipt of vaccine in the following year. Because previous experience with vaccination may be part of the causal pathway, simply adding it to a regression model might actually increase bias instead of reducing it [33].

Increasing parental perception of benefits and reducing the perceived barriers associated with influenza vaccine may be effective strategies for public health interventions. External motivators, such as doctor recommendation, have the potential to modify the effect of various factors, which may have important implications for targeted intervention. Confirmation that modification of these factors will result in behavior change will require longitudinal assessments, preferably with multiple years of survey and documented vaccination data to better address the complicated nature of prior season vaccination.

Acknowledgments

Financial support: This work was supported by the Centers for Disease Control and Prevention through a cooperative agreement with the University of Michigan (U01 IP000170)

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Highlights

- We use a theoretical framework based on the Health Belief Model to examine the association between attitudes and receipt of seasonal influenza vaccine in parents and their children.
- We further examine modification of these associations by cues to action, such as doctor or family recommendation.
- Understanding the factors associated with receipt of seasonal influenza vaccine is essential to improving vaccine uptake.
- Understanding the role that external motivators, such as cues to action, play in modifying the effects of attitudes may lead to targeted interventions.

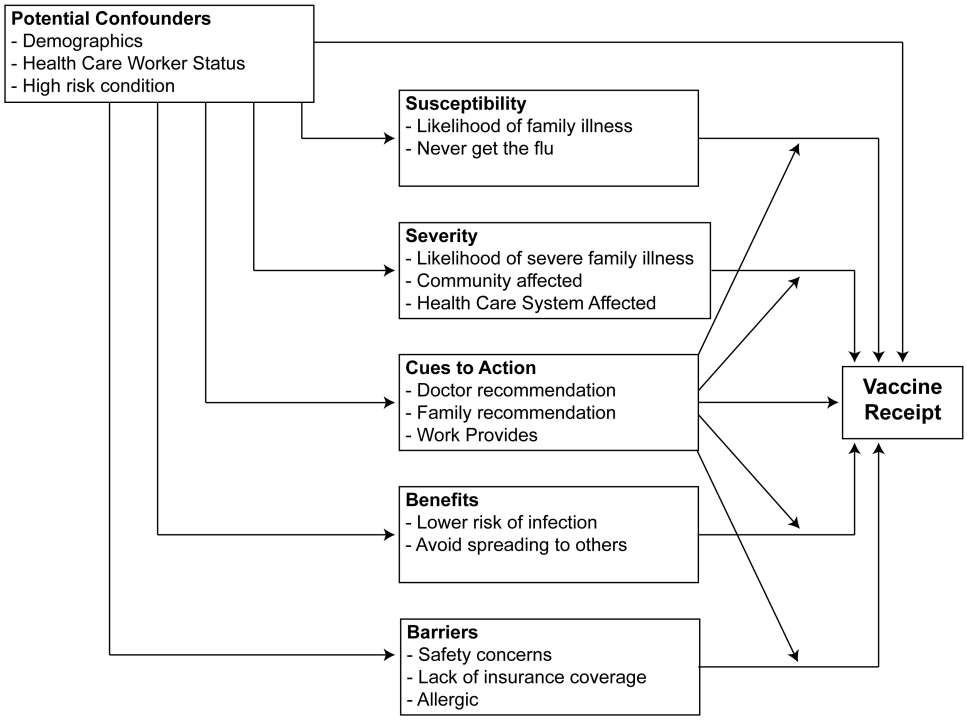

Figure 1.

Theoretical Framework describing the association between Health Belief Model Constructs and receipt of Seasonal Influenza Vaccine

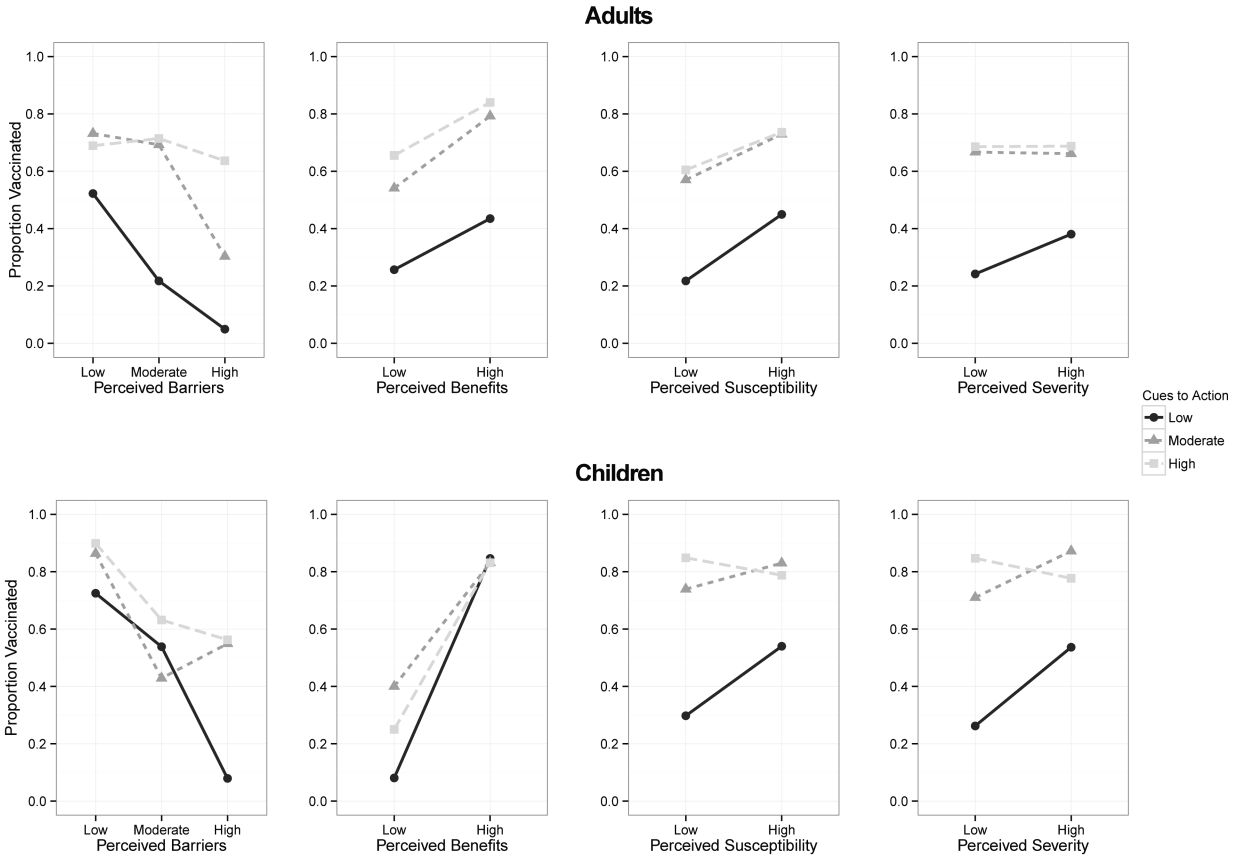

Figure 2.

Table 1

Attitudes toward influenza vaccine, including mean response value and standard deviation of individual survey items which are subsequently summed to create HBM constructs.

			Mean (SD) Response Value			
			Adults		Children	
HBM Construct	**Item**	**Wording**	**Vaccinated**	**Unvaccinated**	**Vaccinated**	**Unvaccinated**
Cue to action	Doctor Recommendation[a]	My health care provider recommends that I get vaccinated	2.3 (0.7)[e]	1.7 (0.8)	2.6 (0.6)[e]	1.8 (0.6)
	Family Recommendation[a]	My friends and/or family recommend that I get vaccinated	1.8 (0.7)[e]	1.5 (0.6)	1.7 (0.6)[e]	1.4 (0.3)
	Work provides[a]	My work provides influenza vaccine for all employees	1.6 (0.9)[d]	1.4 (0.7)	--	--
Perceived Susceptibility	Susceptible to influenz[a, c]	I never get influenza (reverse coded to reflect level of susceptibility)	2.9 (0.4)[e]	2.4 (0.7)	2.9 (0.3)[e]	2.5 (0.6)
	Family ill[b]	You or someone in your family or group of friends will get sick with influenza	2.7 (0.7)	2.6 (0.6)	2.7 (0.5)[d]	2.6 (0.5)
Perceived Severity	Family Severely Ill[b]	You or someone in your family or group of friends will get severely sick (require hospitalization) with influenza	1.4 (0.6)	1.4 (0.6)	1.4 (0.6)	1.4 (0.6)
	Community Affected[b]	Influenza will disrupt your community (example: school closings)	1.6 (0.8)	1.5 (0.8)	1.6 (0.7)	1.6 (0.7)
	Healthcare System Affected[b]	Influenza will disrupt the healthcare system in your area (example: overcrowded hospitals)	1.7 (0.8)	1.5 (0.8)	1.7 (0.7)[d]	1.5 (0.7)
Perceived Barriers	Insurance[a]	The influenza vaccine is not covered by my insurance/I am uninsured	1.1 (0.3)[d]	1.2 (0.5)	1.0 (0.2)[d]	1.1 (0.4)
	Ineffective[a]	I do not think the influenza vaccine works	1.1 (0.4)[e]	1.7 (0.8)	1.1 (0.3)	1.8 (0.8)
	Allergic	I am allergic to a component of the vaccine	1.0 (0.3)	1.0 (0.1)	1.0 (0.2)[d]	1.1 (0.4)
	Unsafe[a]	I do not think the influenza vaccine is safe	1.1 (0.3)[e]	1.5 (0.7)	1.2 (0.4)[e]	1.7 (0.8)
Perceived Benefits	Lower Risk[a]	I want to lower my risk of getting sick with influenza	2.9 (0.4)[e]	2.1 (0.9)	3.0 (0.3)[e]	2.0 (0.8)
	Live/work with High Risk[a]	I live/work with people at high risk of influenza infection	2.1 (0.9)[e]	1.6 (0.8)	--	--

[a] 3-point scale: Please select whether each of the following is a major reason (3), a minor reason (2), or not a reason at all (1), in your decision about whether or not to get an influenza vaccination for yourself [the children in your household] this fall or winter.

[b] Originally measured on a 5-point scale from 1 (unlikely) to 5 (likely), collapsed to 3 categories prior to analysis: Unlikely (1), Neither likely nor unlikely (2), Likely (3)

[c] Item was reverse coded so that higher values reflect higher levels of the HBM construct

[d] $p < 0.05$

[e] $p < 0.0001$

Table 2

Characteristics of Fall 2010 adult survey respondents and the children in those 312 households with at least one adult response.

	Adults (N = 549)[e]		Children (N = 778)[e]	
Demographics	**n**	**%**	**n**	**%**
Female	305	55.6	359	46.1
Age (years)				
< 9 years	--	--	433	55.7
9 - 17 years	--	--	345	44.3
18 – 49 years	495	90.2	--	--
50 + years	51	9.8	--	--
Race				
White	435	79.2	591	76.0
Black	18	3.3	42	5.4
Asian	48	8.7	63	8.1
Other	48	8.7	82	10.5
High Risk Condition	62	11.3	79	10.2
2010-2011 Seasonal Influenza				
Vaccine Receipt	296	53.9	511	65.7
Education[a]				
Less than college graduate	78	14.2	84	10.8
College Graduate	189	34.4	234	30.1
Postgraduate Degree	280	51.0	460	59.1
Occupation				
Health Care Worker[b]	98	17.9	189	24.3
Other	450	82.0	589	75.7

[a] 91.1 % of adults responded to the fall survey; 92.8% of children lived in a household with at least one adult respondent

[b] For children this is the highest reported parental education

[c] For children this is health care worker status of either parent

Table 3

Factors associated with receipt of 2010-2011 seasonal influenza vaccine among adults and children, RR and 95% Confidence Interval presented for unadjusted and adjusted log-binomial regression models

	Adults						Children					
HBM Construct	**Unadjusted**		**Partially Adjusted[a]**		**Fully Adjusted[b]**		**Unadjusted**		**Partially Adjusted[a]**		**Fully Adjusted[b]**	
Perceived Susceptibility												
Low (Referent)	1.00	--	1.00	--	1.00	--	1.00	--	1.00	--	1.00	--
High	1.55	1.30-1.85	1.54	1.30-1.83	1.21	1.03-1.42	1.29	1.10-1.53	1.30	1.11-1.53	0.98	0.88-1.10
Perceived Severity												
Low (Referent)	1.00	--	1.00	--	1.00	--	1.00	--	1.00	--	1.00	--
High	1.13	0.95-1.34	1.13	0.95-1.33	1.09	0.95-1.27	1.24	1.05-1.46	1.25	1.06-1.46	1.13	1.00-1.27
Perceived Benefits												
Low (Referent)	1.00	--	1.00	--	1.00	--	1.00	--	1.00	--	1.00	--
High	1.74	1.45-2.08	1.69	1.42-2.02	1.25	1.04-1.50	6.48	3.82-11.00	6.27	3.72-10.58	4.16	2.28-7.59
Perceived Barriers												
Low (Referent)	1.00	--	1.00	--	1.00	--	1.00	--	1.00	--	1.00	--
Moderate	0.40	0.24-0.66	0.69	0.54-0.89	0.83	0.66-1.05	0.67	0.46-0.97	0.67	0.47-0.95	0.77	0.54-1.11
High	0.12	0.07-0.21	0.29	0.19-0.45	0.38	0.25-0.59	0.33	0.24-0.46	0.32	0.23-0.45	0.58	0.43-0.79
Cues to Action												
Low (Referent)	1.00	--			1.00	--	1.00	--	1.00	--	1.00	--
Medium	2.00	1.62-2.46	2.01	1.62-2.50	1.64	1.31-2.05	2.03	1.57-2.64	1.99	1.54-2.56	1.14	0.94-1.38
High	2.07	1.63-2.63	2.15	1.68-2.76	1.62	1.25-2.10	2.09	1.61-2.72	1.97	1.53-2.55	1.10	0.93-1.31

[a] Adjusted for age, sex, education, health care worker status, and high-risk condition

[b] Adjusted for age, sex, education, health care worker status, high-risk condition and other HBM Constructs

Table 4

Factors associated with receipt of 2010-2011 seasonal influenza vaccine among adults and children, RR and 95% Confidence Interval for adjusted[a] log-binomial regression models stratified by tertiles of Cues to Action Score

	Adults							Children						
Cues to Action	**Low**		**Moderate**		**High**		**p-value[b]**	**Low**		**Moderate**		**High**		**p-value[b]**
Perceived Susceptibility							0.009							0.001
Low	1.00	--	1.00	--	1.00	--		1.00	--	1.00	--	1.00	--	
High	1.96	1.28-2.98	1.27	1.03-1.56	1.20	0.93-1.56		1.96	1.26-3.05	1.10	0.90-1.35	0.93	0.77-1.12	
Perceived Severity							0.018							0.001
Low	1.00	--	1.00	--	1.00	--		1.00	--	1.00	--	1.00	--	
High	1.76	1.13-2.75	1.04	0.86-1.25	0.94	0.73-1.21		1.99	1.18-3.36	1.27	1.03-1.56	0.92	0.77-1.09	
Perceived Benefits							< 0.001							0.002
Low	1.00	--	1.00	--	1.00	--		1.00	--	1.00	--	1.00	--	
High	2.02	1.38-2.95	1.43	1.15-1.78	0.93	0.67-1.28		10.41	5.15-21.04	2.06	0.96-4.41	3.56	1.48-8.53	
Perceived Barriers							0.003							< 0.001
Low	1.00	--	1.00	--	1.00	--		1.00	--	1.00	--	1.00	--	
Moderate	0.50	0.28-0.88	0.95	0.73-1.25	0.95	0.70-1.29		0.68	0.34-1.35	0.51	0.20-1.31	0.73	0.47-1.12	
High	0.11	0.04-0.34	0.41	0.25-0.68	1.03	0.61-1.74		0.11	0.05-0.26	0.64	0.42-0.96	0.59	0.40-0.87	

[a] Adjusted for age, sex, education, health care worker status, and high-risk condition

[b] Reported p-value is for the interaction term of cues to action and each HBM construct from partially adjusted log-binomial regression models