



Theory-based predictors of influenza vaccination among pregnant women

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ABSTRACT

Background: Guidelines recommend influenza vaccination for pregnant women, but vaccine uptake in this population is far below the goal set by Healthy People 2020. The purpose of this study was to examine predictors of seasonal influenza vaccination among pregnant women.

Methods: Between 2009 and 2012, the Vaccines and Medications in Pregnancy Surveillance System (VAMPSS) conducted a prospective cohort study of influenza vaccine safety among pregnant women in the US and Canada that oversampled vaccinated women. Data for the present paper are from an additional cross-sectional telephone survey completed during the 2010–2011 influenza season. We examined predictors of influenza vaccination, focusing on Health Belief Model (HBM) constructs.

Results: We surveyed 199 pregnant women, 81% of whom had received a seasonal influenza vaccine. Vaccination was more common among women who felt more susceptible to influenza ($OR = 1.82$, 95% CI 1.10–3.01), who perceived greater vaccine effectiveness ($OR = 3.92$, 95% CI 1.48–10.43), and whose doctors recommended they have flu shots ($OR = 3.06$, 95% CI 1.27–7.38). Those who perceived greater barriers of influenza vaccination had lower odds of vaccination ($OR = 0.19$, 95% CI 0.05–0.75). Perceived social norms, anticipated inaction regret, and worry also predicted uptake, though demographic characteristics of respondents did not.

Conclusion: The HBM provides a valuable framework for exploring influenza vaccination among pregnant women. Our results suggest several potential areas of intervention to improve vaccination rates.

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1. Introduction

While all healthy adults are eligible for seasonal influenza vaccination in the US and Canada, guidelines recommend vaccination for pregnant women and those who may become pregnant during the influenza season because of their increased risk for influenza-related morbidity and mortality [1,2]. Prior to the 2009 H1N1 pandemic, seasonal influenza vaccination rates among pregnant women were consistently low at around 15% [1–3]. Rates increased significantly to 47% for the seasonal influenza vaccine during the 2009–2010 H1N1 pandemic [4] and remained elevated through the 2010–2011 influenza season [5]. However, these levels remain well below the Healthy People 2020 target of 80%. Some demographic factors associated with influenza vaccination uptake

among pregnant women include older age, access to insurance, and college graduation [5]. Studies also show somewhat higher influenza vaccination rates among non-Hispanic white women as compared to other racial and ethnic groups [6,7].

Behavioral theories provide an a priori framework for explaining why and how a health behavior occurs and provide opportunities to identify potential points of intervention. The Health Belief Model (HBM) [8] focuses on the influence of people's beliefs and attitudes on their health behaviors. The model's constructs are consistently predictive of vaccination behavior across diverse populations [9]. The constructs in the model as applied to influenza vaccination behavior are: (1) perceived susceptibility to contracting influenza; (2) perceived severity of influenza; (3) perceived effectiveness of vaccination to protect against influenza; (4) perceived barriers to vaccination, including practical barriers such as time and effort as well as potential side effects of the vaccine; and (5) cues to action, such as vaccination reminders from healthcare providers.

There is limited understanding of whether constructs from health behavior theories influence vaccination behavior among pregnant women. While researchers have begun to explore individual beliefs and perceptions associated with influenza

Abbreviations: VAMPSS, Vaccines and Medications in Pregnancy Surveillance System; HBM, Health Belief Model.

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vaccination uptake among pregnant women [5–7,10,11], only one specifically identified the HBM as a theoretical framework, and this study did not examine seasonal influenza vaccine uptake [7]. The primary aim of our study was to examine HBM constructs as predictors of seasonal influenza vaccination among pregnant women. Secondarily, we explored how vaccine uptake during pregnancy was associated with other health beliefs and attitudes shown to be predictors of vaccination behavior among healthy adults [12,13]: perceived social norms, anticipated inaction regret (anticipated aversive feelings about not vaccinating given a negative outcome), anticipated vaccination regret (anticipated aversive feelings about vaccinating given a negative outcome), and worry.

2. Materials and methods

2.1. Design of parent study

The Vaccines and Medications in Pregnancy Surveillance System (VAMPSS) influenza vaccine and medications study is a federally funded study initiated in 2009 to monitor and evaluate fetal and maternal risks of H1N1 vaccine, seasonal influenza vaccine, and antiviral medications [14]. One arm of the VAMPSS influenza vaccine study is a prospective cohort study of currently pregnant women. Participants are referred by a network of 13 Teratogen Information Service call centers, located in academic centers and health departments, that respond to calls from across the U.S. and Canada. These centers provide evidence-based counseling and referral to about 70,000–100,000 callers each year about exposures during pregnancy and potential risks for adverse birth outcomes. These services are available free of charge to all women in the U.S. and Canada. The VAMPSS influenza vaccine cohort study planned to recruit 1100 women between October 2009 and February 2012, with 82% vaccinated during any trimester of pregnancy, in order to test specific hypotheses related to adverse pregnancy outcomes.

2.2. Design of additional survey

Between October 2010 and June 2011, participants in the VAMPSS influenza vaccine cohort study were invited to take an additional cross-sectional 15 min telephone survey on their beliefs about seasonal influenza vaccination. Of 438 women enrolled in the cohort study during this time frame, 199 women (45% of those eligible) completed the additional survey. Not all cohort study participants were asked or agreed to complete the additional survey due to telephone interviewer schedules and time limitations for the participants. The University of California San Diego Institutional Review Board approved the parent study and additional survey.

2.3. Measures

The baseline interview for the larger cohort study collected information about demographics, mother's reproductive history, and health behavior in the current pregnancy. In our follow-up interview, 16 items measured 9 individual theoretical constructs (Table 1). Response scales had four response options, coded 1–4 with higher values indicating greater endorsement of the construct. For perceived susceptibility, response options were "very unlikely", "somewhat unlikely", "somewhat likely", and "very likely". For anticipated regret and worry questions, response options were "not at all", "a little", "a moderate amount", and "quite a lot". For all other constructs, response options were "strongly disagree", "disagree", "agree", and "strongly agree". When multiple items measured a construct, we calculated mean scores and Cronbach's alpha to assess internal consistency. We pilot tested

the survey in anonymous telephone surveys with five pregnant or recently pregnant women.

2.4. Statistical analyses

We compared demographics, mother's health behavior, and reproductive history variables by vaccination status using ANOVA, chi-square tests, and Fisher's exact test where appropriate. We calculated raw mean scores of each individual theoretical construct by vaccination status. We then developed logistic regression models to determine the association between vaccination uptake during pregnancy. In the primary analysis, Model 1, we used simultaneous regression based on the a priori theoretical framework of the five HBM domains. For Model 2, we used forward selection stepwise logistic regression to develop the most parsimonious model predicting vaccination. We added each HBM construct into the model followed by the remaining constructs (perceived social norms, anticipated inaction regret, anticipated vaccination regret, and worry) in a stepwise fashion, retaining only those with $p < 0.05$. In exploratory bivariate analyses, we evaluated the correlation between influenza vaccination and specific items measuring barriers to vaccination. We calculated the raw mean score for each items by vaccination status. We analyzed data in SAS Version 9.2 (SAS Institute, Inc., Cary, North Carolina) using two-tailed tests (critical alpha < 0.05).

3. Results

3.1. Respondent characteristics

A total of 199 pregnant women completed the survey. On average, study participants were 32 years old and about 24 weeks' gestation at the time of the survey. The majority of participants were white (non-Hispanic) (83%) and indicated a high socioeconomic status (82%). Rates of tobacco and illicit drug use during pregnancy were 7% and 3%, respectively, and 44% of women reported at least some alcohol exposure (including prior to becoming aware of the pregnancy). This was the first pregnancy for about half of participants, 57% were nulliparous, and 26% had experienced a prior miscarriage. Half of participants (50%) reported they had previously received an influenza vaccination (H1N1 or seasonal), and 19% reported experiencing influenza, in the previous influenza season (2009–2010).

3.2. Influenza vaccination

For the 2010–2011 influenza season, 81% of participants had received a seasonal influenza vaccine during or prior to pregnancy. In a comparison of characteristics across vaccination uptake groups, those vaccinated were more likely to have received an influenza vaccination in the previous influenza season ($p < 0.001$) (Table 2). Those who had received an influenza vaccination in the previous season had higher odds of vaccination than those who had not (91.8% vs. 68.5%; OR = 5.15, 95% CI 2.28–11.64). There were no statistically significant differences in the 11 other characteristics (demographics, health behaviors, reproductive history, or prior season influenza) by vaccination status.

3.3. Health beliefs

In bivariate analyses, participants who received an influenza vaccine had higher perceived susceptibility to influenza ($p < 0.001$), perceived severity of influenza ($p < 0.001$), perceived effectiveness of the vaccination ($p < 0.001$), perceived social norms regarding vaccination during pregnancy ($p = 0.06$), anticipated inaction regret ($p < 0.001$), and worry ($p < 0.001$) (Table 3). Those who received the

Table 1
Assessment of theoretical constructs.

Construct	Item wording	Cronbach's alpha
Perceived susceptibility to flu	With no flu shot, what would you say is the chance that you would get the flu this winter? Remember, the flu refers to any flu, including the seasonal or H1N1 flu	–
Perceived severity of flu	If I have the flu, it could lead to serious health problems for me If I have the flu, it could lead to serious health problems for my baby	0.79
Perceived effectiveness of vaccination	If I have the flu, I won't be able to manage my daily activities Getting a flu shot will protect me against getting the flu Getting a flu shot will protect my baby's health	0.86
Barriers related to vaccination	It is too much trouble to get a flu shot Flu shots are too expensive Having a flu shot during pregnancy could harm my baby Flu shots have dangerous side effects during pregnancy Having a flu shot during the first trimester could harm my baby	0.75
Cues to action	Please say how many times these things have happened during your current pregnancy... My doctor reminded me to get a flu shot, such as during an office visit, with a telephone call, or by sending me a letter ^a	–
Perceived social norms	Most pregnant women are probably getting a flu shot this year	–
Inaction regret	Now, imagine that you did not get a flu shot and are hospitalized for pregnancy complications resulting from the flu. How much would you regret that you did not get a flu shot?	–
Vaccination regret	Now, imagine that you did get a flu shot, and afterward are hospitalized for pregnancy complications. How much would you regret that you did get a flu shot?	–
Worry	With no flu shot, how worried would you be about getting the flu this winter?	

Note. Response scales range 1–4.

^a Item dichotomized (never vs. one or more times) for analyses.

influenza vaccine also had lower mean scores of perceived barriers to vaccination ($p < 0.001$) and anticipated vaccination regret ($p < 0.001$). A higher percentage of those who received a vaccine reported being reminded by their doctor to do so (66% vs. 35%, $p < 0.001$). These results are in the expected directions and consistent with the theoretical framework (Table 3).

In a multivariate logistic regression model simultaneously controlling for all five HBM constructs (Model 1, Table 3), those with higher perceived susceptibility to influenza ($OR = 1.82$, 95% CI 1.10–3.01), those with higher perceived vaccine effectiveness ($OR = 3.92$, 95% CI 1.48–10.43), and those who were reminded by their doctor to have a flu shot (representing cues to action) ($OR = 3.06$, 95% CI 1.27–7.38) had higher odds of influenza

vaccination. Those with higher perceived barriers had lower odds of vaccination ($OR = 0.19$, 95% CI 0.05–0.75).

In the multivariate logistic regression model to explore the role of "other beliefs" predicting vaccination (Model 2, Table 3), those who were reminded by their doctor to have a flu shot ($OR = 3.08$, 95% CI 1.18–8.07), those who believed that most other pregnant women received an influenza vaccination ($OR = 5.31$, 95% CI 1.75–16.13), those with higher anticipated inaction regret ($OR = 1.97$, 95% CI 1.11–3.48), and those with greater worry about influenza ($OR = 1.90$, 95% CI 1.04–3.47) had greater odds of vaccination. Those with higher perceived barriers had lower odds of vaccination ($OR = 0.16$, 95% CI 0.04–0.72). In the step of the analysis that added worry, both perceived susceptibility and

Table 2
Respondent characteristics as correlates of influenza vaccination (unadjusted analyses).

	Not vaccinated (n = 37) n (%)	Vaccinated (n = 162) n (%)	p
Demographics			
Age at EDD (mean, SD)	32.2 (5.0)	31.7 (4.6)	0.55
Socio-economic status ^a			0.47
Low	2(5.6)	11(6.8)	
Medium	6(16.6)	16(9.9)	
High	28(77.8)	135(83.3)	
Race/ethnicity			0.22
White (non-Hispanic)	28(75.7)	137(84.6)	
Black	1(2.7)	5(3.1)	
Hispanic/Latina	4(10.8)	13(8.0)	
Asian/Pac Islander	2(5.4)	6(3.7)	
Other/Unknown	2(5.4)	1(0.6)	
EGA at time of survey (weeks) (mean, SD)	23.4 (11.1)	24.1 (8.9)	0.68
Risk behaviors during current pregnancy			
Any tobacco use	1(2.7)	13(8.0)	0.47
Any illicit drug use	2(5.4)	3(1.9)	0.23
Any alcohol use	12(32.4)	76(46.9)	0.14
Reproductive history			
First pregnancy	17(46.0)	69(42.6)	0.71
First live birth	21(56.8)	93(57.4)	0.94
Previous miscarriage	7(18.9)	44(27.2)	0.30
Previous season influenza and vaccination			
Had influenza prior season	6(16.2)	31(19.1)	0.68
Received influenza vaccine prior season	9(24.3)	101(62.4)	<0.001

Note. EDD, estimated date of delivery; SD, standard deviation; EGA, estimated gestational age.

^a SES calculated using the Hollingshead four factor index (Hollingshead, 1975) (N = 198).

Table 3

Correlates of influenza vaccination.

	Not vaccinated (n = 37) Mean (SD)	Vaccinated (n = 162) Mean (SD)	Bivariate analyses OR (95% CI)	Multivariate analysis, Model 1 OR (95% CI)	Multivariate analysis, Model 2 OR (95% CI)
HBM influenza beliefs					
Perceived susceptibility	1.99 (0.80)	2.68 (0.90)	2.43 (1.56–3.79)**	1.82 (1.10–3.01)*	Not sig.
Perceived severity	2.66 (0.68)	3.07 (0.62)	2.74 (1.53–4.92)**	0.88 (0.36–2.14)	Not sig.
HBM vaccination beliefs					
Perceived effectiveness	2.40 (0.73)	3.09 (0.51)	7.77 (3.60–16.77)**	3.92 (1.48–10.43)*	Not sig.
Perceived barriers	2.20 (0.42)	1.84 (0.36)	0.06 (0.02–0.20)**	0.19 (0.05–0.75)*	0.16 (0.04–0.72)*
Cue to action (n, %)	13 (35)	107 (66)	3.59 (1.70–7.60)**	3.06 (1.27–7.38)*	3.08 (1.18–8.07)*
Other beliefs					
Perceived social norms	2.70 (0.44)	2.85 (0.44)	2.11 (0.98–4.57)		5.31 (1.75–16.13)*
Anticipated inaction regret	2.72 (1.18)	3.74 (0.63)	3.14 (2.09–4.72)**		1.97 (1.11–3.48)*
Anticipated vaccination regret	2.87 (1.05)	2.06 (1.05)	0.57 (0.42–0.77)**		Not sig.
Worry	1.72 (0.67)	2.64 (1.03)	2.87 (1.81–4.55)**		1.90 (1.04–3.47)*

Note. HBM, Health Belief Model. Model 1 included all HBM variables in a simultaneous logistic regression. Model 2 used forward stepwise logistic regression retaining theoretical constructs with $p < 0.05$.

* $p < 0.05$.

** $p < 0.001$.

Table 4

Exploratory bivariate analyses of barriers as correlates of influenza vaccination.

	Not vaccinated (n = 37) Mean (SD)	Vaccinated (n = 162) Mean (SD)	OR (95% CI)
It is too much trouble to get a flu shot	1.94 (0.62)	1.65 (0.49)	0.32 (0.15–0.69)*
Flu shots are too expensive	1.70 (0.50)	1.64 (0.56)	0.83 (0.43–1.58)
Flu shots have dangerous side effects during pregnancy	2.29 (0.70)	1.92 (0.43)	0.23 (0.11–0.50)**
Having a flu shot during the first trimester could harm my baby	2.52 (0.55)	2.04 (0.58)	0.24 (0.12–0.47)**
Having a flu shot during pregnancy could harm my baby	2.54 (0.65)	1.93 (0.52)	0.15 (0.07–0.32)**

* $p < 0.05$.

** $p < 0.001$.

perceived effectiveness lost statistical significance. Worry was moderately correlated with both perceived effectiveness ($r = 0.44$) and perceived susceptibility ($r = 0.45$). Adding prior season vaccination behavior did not change the statistical significance of any variables in Model 1 or Model 2.

In exploratory bivariate analyses, four of the five items measuring barriers were associated with vaccination status ($p < 0.05$) and all scores were in the expected direction (higher mean scores for those not vaccinated). Only the item measuring cost as a barrier did not differ between groups (Table 4).

4. Discussion

Influenza vaccination rates among pregnant women have increased following the 2009–2010 influenza season, but they have remained below the 80% goal set by Healthy People 2020 [5,15]. Previous research indicates that the HBM's constructs are among the most important predictors of vaccination decisions [9]. However, theory-based research of influenza vaccination among pregnant women is limited. Our results suggest that the HBM provides a valuable framework for exploring influenza vaccination among pregnant women and that “other beliefs” deserve further evaluation. Our findings also point toward several potential areas of intervention to improve influenza vaccination uptake among pregnant women.

Consistent with other research [4,5,10,16], we found that healthcare providers played an important role in encouraging vaccination. Participants who reported that a doctor had reminded them to have a flu shot at least once during their pregnancy had three times the odds of being vaccinated compared to those who had not been reminded. This also suggests that, even if a doctor is unable to provide an influenza vaccination at that time, the reminder is still beneficial. The findings of this and other studies indicate that patient-provider communication regarding vaccination recommendations during pregnancy continue to be important.

Women who do not have annual flu vaccines may also represent a higher risk group for targeted communication efforts during pregnancy. As in other studies [5,9], those who had an influenza vaccination in the previous season had higher odds of vaccination than those who had not.

Perceived susceptibility to influenza, effectiveness of vaccination, and barriers were also statistically significant predictors in an analysis using the five main HBM constructs. Women who believed they were more susceptible to influenza and those who believed that vaccination would provide protection against influenza had greater odds of vaccination. This is consistent with research indicating lower vaccination rates among pregnant women with beliefs that contracting influenza is not likely and that vaccines are not effective [5–7,10,11]. Yudin and colleagues found that pregnant women have limited understanding of their susceptibility to influenza, current vaccination recommendations, and safety of vaccination during pregnancy, which could impact vaccination uptake [11]. In our exploratory bivariate analysis, those who felt that vaccination posed a risk to themselves or their baby had lower odds of vaccination. This is consistent with a recent CDC survey, which found that 37% of women reported having concerns about safety risks to themselves or their baby as reasons for not receiving an influenza vaccination [5]. Beliefs about the severity of having the flu during pregnancy did not remain statistically significant after controlling for other HBM constructs. While a recent CDC survey cites beliefs about the severity of getting the flu (“I don't think I would get very sick if I got the flu” and “If I get the flu, I will just get some medication to treat it”) among the top five reasons for not receiving an influenza vaccination during pregnancy [5], these are different aspects than we assessed. A cross-sectional study undertaken during the 2009 H1N1 epidemic found that perceived severity was an independent predictor of influenza vaccination among pregnant women [7], but results may have been influenced by the intense media coverage regarding H1N1 during that time. Results of our study suggest that health communication campaigns focused on

awareness of susceptibility to influenza and vaccine effectiveness during pregnancy in combination with efforts to address safety concerns, such as through patient-provider interaction and dissemination of relevant research and recommendations, may help pregnant women make informed vaccination decisions.

Social norms theory suggests that perceptions about how others in their social group are behaving (descriptive norms) influence people's behavior [17–19]. This theoretical approach has been used extensively in the development of interventions to reduce risk behaviors such as substance use, particularly among college students [17,18]. The results of Model 2 indicate that this theory may also be useful in predicting vaccination behavior; women who believed that other pregnant women were having influenza vaccinations had greater odds of vaccination. If vaccination rates are higher than most women believe them to be, then interventions presenting accurate information about influenza vaccination among pregnant women in their peer group may be beneficial in encouraging vaccination. However, such an approach would not be effective, and could have unanticipated negative effects, if vaccination behavior is less common than believed [20].

Our findings suggest that emotional aspects of risk, such as anticipated inaction regret and worry, are important constructs to consider when exploring determinants of vaccination behavior [9,13,21]. Researchers have found anticipated regret to be important predictors of vaccination in other populations [13,21–23]. Weinstein and colleagues found that adults with higher scores of inaction regret, those who would regret getting the flu because they were not vaccinated, were more likely to be vaccinated [21]. Our study results are consistent with this; pregnant women with higher scores of anticipated inaction regret had higher odds of vaccination. Results presented in Model 2 also suggest that worry may be an important predictor of vaccination, and may be a stronger predictor than perceived susceptibility to influenza or perceived vaccine effectiveness. The findings may also be consistent with mediation, such that cognitive evaluations lead to affective responses which more proximally motivate behavior, as proposed by Kiviniemi and colleagues [24]. While worry was moderately correlated with both perceived susceptibility and perceived effectiveness, these remain distinct theoretical constructs [13]. Further research to identify individual and environmental factors associated with worry and anticipated regret of not being vaccinated could aid in the development of effective vaccination promotion campaigns.

4.1. Study limitations and strengths

A strength of this study was enrollment of geographically diverse participants from the US and Canada and use of a theoretical framework. A main limitation is that this was a cross-sectional study, limiting our ability to make causal inferences [25]. This sample is not representative of pregnant women in general as participants were a convenience sample from a larger cohort study that was not designed to reflect population vaccination rates. Because most participants were recruited through Teratogen Information Services, it is also possible that women in this study were more concerned about their prenatal health because of co-morbidities, additional exposures, or other health concerns and therefore, responded differently to health behavioral questions such as perceived susceptibility. Most were White (non-Hispanic) and had a high socioeconomic status [26]. Influenza vaccination status was self-reported by participants and not verified by medical record. However, while no studies address the validity of self-reported influenza vaccination among pregnant women, recall is moderately reliable among elderly populations and other risk groups [27–29]. Finally, we relied on self-report of having received a doctor's reminder to have an

influenza vaccination during pregnancy. It is possible that some women did not recall this information accurately.

5. Conclusions

Health behavior theories, such as the HBM, provide a valuable framework for increasing our understanding of factors associated with vaccination behavior. The results of this study indicate that perceived susceptibility to influenza, perceived effectiveness of vaccination, perceived barriers (particularly those related to harms of vaccination), and cues to action via a doctor's reminder independently predict influenza vaccination during pregnancy. Perceived norms regarding vaccination, anticipated inaction regret, and worry also appear to be important. Campaigns addressing these issues along with sustained health communication efforts among health care providers may help to maintain and improve vaccination rates.

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