RISK PERCEPTIONS, PAST VACCINATION, AND VACCINE ACCEPTANCE FOR SEASONAL AND OUTBREAK (2009 H1N1) INFLUENZAS AMONG A UNIVERSITY SAMPLE

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RISK PERCEPTIONS, PAST VACCINATION, AND VACCINE ACCEPTANCE FOR

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ABSTRACT

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Over the past decade illness outbreaks have posed a serious threat to human life and well-being. The 2009 outbreak H1N1/A influenza virus also was expected to disproportionately affect healthy, young persons under the age of 25 years. However, acceptance and uptake of preventive health behaviors among this cohort is poorly understood, thus precluding a comprehensive understanding of this group's perceptions of outbreak illnesses as well as acceptance of vaccination efforts intended to control the spread and associated morbidity of either seasonal or outbreak influenza in this cohort. The Health Belief Model (HBM) is used as the framework of this thesis research to model vaccine acceptance among 158 university members through multiple hierarchical logistic regression modeling of cross-sectional survey response data. Models were constructed for both seasonal and outbreak influenzas to determine if four risk perceptions and past uptake of the seasonal flu shot were associated with vaccine acceptance while exploratory tests of interaction effects were also included in the regression models. Results provide support for the HBM-defined relationships between risk perceptions and vaccine acceptance group membership. Significant differences were found between perceived likelihood and severity of the two influenzas, as well as for perceived risks of the two vaccines in within-groups analysis. Between-groups analysis indicated that the perceived likelihood dimension interacts with past flu shot uptake in subgroup analysis in predicting acceptance of the seasonal flu shot for members who do not typically receive the seasonal flu shot, but not for those who report past flu shot uptake. Though factors associated with vaccine acceptance are similar between outbreak and seasonal influenzas, the presence of this interaction effect may be replicated and thus shed light on this cohort's use of preventive health behaviors such as vaccination that may be used only infrequently, but have been shown to be important for control and prevention of common and outbreak forms of influenza viruses.

I: BACKGROUND AND RATIONALE

A series of novel flu outbreaks during the past decade have emerged as an imminent threat to human life (e.g. Severe Acute Respiratory Syndrome, or SARS in 2002-2003, avian flu in 2004, and swine flu in 2009). In March 2009, a new influenza virus called "swine flu" first appeared in Mexico, with the first United States patient case confirmed by the Centers for Disease Control and Prevention (CDC) on April 15. On April 26, a public health emergency was declared by the United States government. Then, on June 11, the World Health Organization raised the worldwide pandemic alert level to 6, its highest level, due to a global pandemic of novel influenza A (H1N1). By June 19, all states in the U.S. had reported cases of novel H1N1 infection. Early estimates of H1N1 incidence rates per 100,000 by July 24 strongly suggested that the H1N1 was disproportionately infecting individuals under 25 years of age. With 2009 H1N1, approximately 90% of estimated hospitalizations and 87% of estimated deaths from April through January 16, 2010 occurred in people younger than 65 years old. In contrast, with seasonal influenza, about 60% of seasonal flu-related hospitalizations and 90% of flu-related deaths occur in people 65 years and older ("Use of influenza A (H1N1) 2009 monovalent vaccine," 2009). In October 2009, initial supplies of the H1N1 vaccine were released in the United States, but not without concerns about safety and a limited supply at the local level. On December 13, a vaccine outreach program hosted by the Student

Health Center at Texas State University-San Marcos began to provide the H1N1 vaccine to students and staff of the university. Over the following two weeks, university students and staff members were recruited for this study through in-class announcements and upon exiting the vaccine outreach campaign locations. Online survey data was collected from 166 university members in order to assess the associations of past vaccination uptake and various risk perceptions on vaccine acceptance for the seasonal flu shot and the newly developed H1N1 vaccine.

In a typical year in the United States there are an estimated 20-50 million cases of influenza, resulting in hundreds of millions of days of illnesses and tens of millions of days of work and school lost. Seasonal influenza is the single greatest cause of vaccine-preventable disease mortality, causing an estimated 250,000-500,000 deaths annually worldwide and 30,000-50,000 deaths in the United States. Influenza-related illnesses and deaths occur most frequently among the elderly (> 65), young children (< 2), and persons with health conditions (e.g., chronic heart, lung, renal, liver disease; cancer or immunosuppression; or pregnancy) that place them at risk for developing serious influenza-related health complications (Nichol & Treanor, 2006). Only recently have researchers began to investigate the burden of influenza among college students (Nichol, & Treanor, 2006; Nichol, D'Heilly, & Ehlinger, 2008). Studies of the incidence and impact of influenza and influenza-like-illnesses (i.e., other upper-respiratory infections) indicate that college students are more likely to suffer from influenza illnesses than the general population and exhibit significant morbidity associated with influenza infection (Nichol, D'Heilly, & Ehlinger, 2005). However, this cohort is among the least likely to receive the seasonal flu vaccine (Nasi, Bosse, & Hayney, 2009). Receiving the seasonal flu vaccine has been shown to significantly reduce the negative impact of influenza-like illnesses on absences, academic performance, and healthcare utilization costs of students (Nichol et al., 2008). Indirect benefits of vaccination include the prevention of transmission of the flu among household and community members as well as cost savings across the age spectrum as a result of being vaccinated for seasonal influenza (Nichol & Treanor, 2006).

There are several important options for preventing and controlling influenza. Simple methods such as hand hygiene, cough etiquette, and contact avoidance have a significant impact on decreasing the number of cases in an outbreak (Fiore et al., 2008). However, it is well established that vaccination is the most effective means of preventing influenza infection for oneself and potentially transmitting the virus to others. Vaccination uptake, however, is suboptimal for all groups. Over the previous 2007-2008 flu season, acceptance of the seasonal flu vaccine was 17% among the healthy adult population aged 18-49 years of age, and 38.8% among 18-64 year olds with conditions that placed them at high risk for complications from influenza (Nichol & Treanor, 2006).

The vast majority of prior research concerning the impact of seasonal influenza and factors associated with adherence to vaccination recommendations has historically focused on elderly adults, young children, individuals living with health conditions known to be associated with more severe infection-related complications, and persons likely to transmit the virus to such at-risk individuals (e.g., healthcare workers). There is sparse research related to immunization-seeking behaviors of the college-aged segment of our population. Of even greater concern is the absence of research regarding novel influenza strains which may disproportionally impact groups who are not typically considered to be at risk for infection-related morbidity or mortality with regard to the typical seasonal flu. As such, little is known about the influential factors affecting vaccination uptake among college students with regard to outbreaks such as the 2009 H1N1 influenza. Public health campaigns and the research literature may be better informed through a more thorough investigation of the factors that influence acceptance of newly developed vaccines under similar outbreak contexts.

Risk perceptions (i.e., beliefs about potential harm) are fundamental elements of health behavior theories such as the Health Belief Model (Rosenstock, 1966; Janz & Becker, 1984) and protection motivation theory (Rogers, 1975). Risk perceptions are also implied by more general behavioral theories applied to health actions, including the theory of planned behavior (Ajzen, 1991) and the subjective-expected utility theory (Ronis, 1992). The aim of this study is to investigate the social-cognitive characteristics associated with H1N1 influenza and its vaccine through the theoretical framework of the HBM for preventive health behaviors (Janz & Becker, 1984) with a conceptual focus on the role of risk perceptions as they are related to acceptance of vaccines for seasonal and outbreak influenzas. The HBM was chosen as the theoretical framework for this thesis because of its demonstrated utility and cross-theoretical generalizability of its core constructs to other health behavior theories. The core constructs of the HBM (perceived severity, perceived susceptibility, perceived benefits, and perceived barriers) have empirical utility in explaining vaccination intentions and uptake behavior, and have proven useful in assessment of the characteristics of vaccine acceptance for hypothetical vaccines (Brewer et al., 2007; Chapman & Coups, 1999).

This exploratory study is a descriptive-comparative analysis. This study seeks to address both the lack of research pertaining to university members' perceptions of influenza outbreaks and the influence of past preventive health behaviors on attitudes towards vaccination for both seasonal and outbreak influenzas. Few studies have investigated social cognitive factors for other immunizations in this age-cohort and their motivations for preventive health behaviors are poorly understood. The 2009 outbreak of H1N1 influenza provided a unique opportunity to assess and compare social cognitive factors among such an atypical at-risk cohort. There is an urgent need for theory-driven research among college-aged individuals to inform vaccination outreach programs and similar public health initiatives designed to decrease the impact of future pandemic illnesses similar to the present H1N1 outbreak. Such theoretically-based empirical evidence regarding the social cognitive characteristics of vaccine acceptance among college students and other members of the university may serve to inform health psychology research as well as evidence-based public health initiatives for increasing vaccination acceptance (i.e., positive attitudes towards vaccines) and preventive health behavior (i.e., vaccination uptake) for the purpose of controlling future outbreak illnesses among similar scenarios within the context of outbreak illness.

The overall aim of this study to explore the role of perceived risks associated with seasonal and outbreak H1N1 influenza. This study seeks to fulfill four research objectives. The two primary research objectives seek to (1) provide a comparative analysis of risk perceptions between influenza types, and second, (2) to assess how risk perceptions and past vaccination for the seasonal flu are related to acceptance of vaccines for both seasonal and outbreak influenzas. The secondary research objectives seek to assess for interactions, both between (3) risk perceptions, and between (4) risk perceptions and past vaccination for the seasonal flu on vaccine acceptance for the current seasonal flu shot and the newly released H1N1 vaccine. These objectives are described in further detail in the following sections.

In order to achieve these objectives, this study utilized a descriptive-comparative design, mixed between- and within-subjects statistical analysis procedures, and a survey instrument designed by the researcher to assess theory-based risk perceptions regarding seasonal and outbreak influenzas, clinical and demographic information among a university-derived sample. The questionnaire was administered online to collect cross-sectional data from a convenience sample of 158 volunteer university members. Both the research design and construction of the research instrument were guided by the theoretical framework of the HBM as well as prior research on vaccine acceptance among college students and healthy working populations.

Objective 1: Comparison of risk perceptions between seasonal and H1N1 influenza.

The first research objective involves contrasting risk perceptions for seasonal and outbreak influenzas to determine whether perceived risks related to influenza and vaccines are different between influenza types among members of a university sample. The research question posited here is comparative in nature; asking whether risk perceptions differ between seasonal and outbreak influenzas and their respective vaccines. In order to compare risk perceptions between seasonal and outbreak influenzas within-subjects, direct difference t-tests are used to assess mean levels of perceived risks between measures of risk perceptions for seasonal and outbreak H1N1 influenzas. The null hypotheses tested here state that no differences in mean levels of risk perceptions (perceived severity, perceived susceptibility, perceived vaccine efficacy, and perceived vaccine risks) will be observed between seasonal and outbreak H1N1 influenza types. Failure to reject the null hypotheses may suggest that there are no differences in perceived risks between influenza illnesses and their vaccines between seasonal and outbreak influenzas, and, by extension, that the different rates of vaccine acceptance may not be affected by differences in perceptions between the two influenza types and their vaccines. Rejection of the null hypotheses would suggest that different rates of vaccine acceptance might be influenced by such differences in perceived risks between influenza types. Given that no prior research has been conducted that compares risk perceptions between seasonal and outbreak flu types for such a sample, no specific alternative research hypotheses are made to predict any observed differences between flu types. Data obtained from the present sample will serve to better inform the discussion of different relations of the risk perceptions to vaccine uptake for each of the two influenzas under investigation.

Objective 2: Assessment of factors associated with vaccine acceptance

The second objective of the present research is to assess the relationships between risk perceptions and vaccine acceptance for seasonal and outbreak H1N1 influenzas. The research question asks which, if any, of the risk perceptions are related to vaccine acceptance for the seasonal flu shot and the newly developed H1N1 vaccine. The associations of the four risk perceptions with vaccine acceptance for seasonal and outbreak influenzas are analyzed separately through multiple logistic regression models on the binary outcome of vaccine acceptance group membership, predicted from the four risk perceptions. Additionally, perceptions of typical past uptake of the seasonal flu shot will be assessed as an additional predictor of vaccine acceptance in sequential logistic regression analysis after controlling for the effects of risk perceptions.

Assuming that the social cognitive factors associated with acceptance of the H1N1 vaccine will be similar to those of the seasonal flu shot (Maurer, Uscher-Pines, & Harris, 2010), parameter estimates obtained from separate logistic regression models on vaccine acceptance should be similar in both direction and magnitude. Results from prior research indicate that vaccination acceptance is positively related to perceptions of illness severity and likelihood of becoming ill, as well as with perceptions of vaccine efficacy (Brewer et al., 2007). However, the relationship between vaccine acceptance and perceived risks of vaccination is strongly negatively associated with vaccine acceptance (Armstrong, Berlin, Schwartz, Propert, & Ubel, 2001). According to early survey studies on intentions to receive the H1N1 vaccine (Maurer et al., 2010), the role of past seasonal flu shot uptake is also expected to be strongly associated with uptake of both the seasonal flu shot and the H1N1 vaccine. These five research hypotheses are expected to be observed for both seasonal and outbreak influenzas, respectively.

Objective 3: Assessment of Interactions Among Risk Perceptions

In addition to the main effects defined above, interactions between risk perceptions regarding the perceived severity and perceived likelihood of becoming ill are tested in an exploratory analysis of possible interaction effects. Expectancy-value theories such as the HBM posit that individuals base decision-making processes concerning a given health behavior on subjective evaluations of both the value and probability of the expected outcomes of taking a given health action. Through a conscious or non-conscious evaluation, an individual bases their decision to take a specified action through weighing the costs and benefits regarding the omission or commission of the action under consideration (Rosenstock, 1966). In other words, it is unlikely to expect an individual to perform a given health-protective behavior if the hazard to be avoided is perceived as having a near zero likelihood of occurring. The interaction between pairs of risk perceptions between perceived severity and perceived likelihood will be tested through hierarchical logistic regression analysis procedures.

Objective 4: Moderation of Risk Perception-Vaccine Acceptance Relationship by Past Flu Shot Uptake

Several studies have indicated that past year uptake of the seasonal flu shot is a strong predictor of subsequent intentions and uptake behaviors for both seasonal and outbreak influenza (Maurer et al., 2010). However, it is not known whether the association between various risk perceptions and vaccine acceptance differ according to prior vaccine uptake experiences performed for the seasonal flu shot. In order to test whether past vaccination status moderates the relationships between risk perceptions and vaccine acceptance, exploratory runs of the logistic regression analyses that include multiplicative interactions formed between risk perceptions and past habitual flu shot acceptance status are performed to assess for overall effects prior to running a reduced model that includes only significant interaction terms, if any are detected. The interaction assessments between the four risk perceptions and past flu shot uptake status is performed through hierarchical logistic regression analysis procedures.

Assumptions, Limitations, and Delimitations

This study assumes that awareness of the H1N1 influenza outbreak is universal and consistent for all members of the study sample. Media coverage of the H1N1 influenza and the development of the vaccine were substantial for several months prior to data collection. Posters and placards designed to inform students about appropriate flu etiquette and personal hygiene to prevent contracting and transmitting influenza had been posted on campus. Email updates concerning the local status of the H1N1 outbreak and the availability of its vaccine were sent to all members of the university on a monthly basis.

It is assumed that vaccine acceptance may be inferred by individuals who stated that they plan to be vaccinated, allowing for the combination of individuals who have already been vaccinated with those who intend to receive the vaccine into a single group of vaccine accepters. Conditioning risk perception items on the real or hypothetical situation of not being vaccinated are presumed to reduce the differences in perceived risks between those who plan to be vaccinated and those who are already vaccinated (Weinstein et al., 2007). Supplementary t-tests are performed to test the presumption that vaccine intenders and accepters are equivalent on measures of perceived risks.

Limitations of the present research include nonprobability sampling procedures, cross-sectional design, and retrospective self-report data. Sample size considerations presented several limitations to the analysis, including the following: the loss of information through collapsing discrete categories, artificial dichotomization of both numerical and categorical data, and lack of theoretical saturation due to the exclusion of several theoretical predictors that were not considered to be of primary importance to the current research. The limited sample size also precluded cross-validation of the study's findings through a separate sample. With regard to the lack of theoretical saturation of this study, the decision to focus on the core constructs of the HBM is a limitation imposed by the researcher in addressing risk perception constructs which span across various theories of health behavior.

Issues of causality between predictors and outcomes cannot be ignored in cross-sectional research such as the present study. The bidirectional nature of risk perceptions is exemplified in prior research efforts that did not control for prior behavior or intentions to vaccinate when measuring perceived risks (Brewer et al., 2007; Brewer, Weinstein, Cuite, & Herrington, 2004; Weinstein, Rothman, & Nicolich, 1998). As mentioned earlier, conditioning risk perception items to specific behavioral contexts is assumed to control for intentions to vaccinate at a later time (Weinstein et al., 2007). Although findings of the present study may not be interpreted as causal in nature, they may be used to inform future research on preventive health psychology and studies of vaccine acceptance in future outbreak scenarios.

This study is delimited by its institutional setting at a central Texas university with publicly documented cases of H1N1 infection and by the characteristics of the university members (including students, faculty, and staff) who were eligible to respond to the survey. Restrictions concerning the study's context during the H1N1 pandemic and results derived from data collected from the present study's sample, which consisted primarily of atypical at-risk individuals (i.e., healthy young adults) focuses the research on similar university-based samples within the context of future influenza outbreaks. The timeframe during which data was collected delimits the study's findings to similar later phases of the pandemic in which a vaccine has recently become available for use by the general public. Characteristics of the sample confine the study's findings to similar university-aged cohorts with access to the internet.

Chapter 1 of this thesis introduced the context of the present research, a statement of the problem, and objectives of the present research. Additionally, the conceptual basis of the study was established, along with the methodological and theoretical limitations and assumptions. The second chapter presents a review of the literature concerning the background of the present research, including CDC recommendations for vaccination, the Health Belief Model, and the research variables used in the present analysis. The methodology for this study is presented in Chapter 3 and includes a description of the research instrument and variables, the research design, sampling procedures, and the methods and procedures used in data collection and analysis. Chapter 4 presents the results of this analysis. The final chapter, Chapter 5, interprets the findings and discusses the implications for future research endeavors.

II: LITERATURE REVIEW

This chapter presents a review of the literature concerning the theoretical and conceptual basis of this study, as well as the rationale and operationalization of the study's research variables.

CDC Influenza Vaccine Recommendations

Each year, the Centers for Disease Control and Prevention's Advisory Committee on Immunization Practices (ACIP) make recommendations for high-priority vaccination groups based on epidemiologic and clinical data of previous-year and currently-circulating influenza strains. The ACIP's findings are used to inform vaccine production facilities as to the strains to be included in the trivalent seasonal influenza vaccine for the upcoming flu season, and to guide the CDC's recommendations for vaccination among target groups.

In a special report released on August 21, 2009, the ACIP reviewed the past five months of epidemiologic and clinical data regarding the H1N1 outbreak and made recommendations for two sets of high-priority vaccination groups with considerations for future vaccine availability. Data from March to August 2009 noted that the H1N1 influenza has evidenced an atypical infection pattern with relatively few severe cases occurring among older persons, and the highest hospitalization rates among persons under 65 years of age. As of July 31, 2009, the median age of persons infected with laboratory confirmed H1N1 infections in the United States was 12 years, and the highest rate of infection incidence was among persons aged 5-24 years. Medical risk factors for severe H1N1 infection are similar to those found for seasonal influenza (e.g. chronic heart, lung, renal, liver disease; cancer or immunosuppression; or pregnancy). However, outbreaks attributable to H1N1 virus among older adults in long-term-care facilities have not been reported even when it has been identified among healthcare workers in these facilities who worked while ill. In contrast, outbreaks in settings where young persons congregate (e.g. schools, colleges, and camps) have been a frequent source of community transmission (“Interim results,” 2010, “Use of influenza A (H1N1) 2009 monovalent vaccine,” 2009).

On the basis of these findings and projections for the availability of the monovalent H1N1 vaccine (which was still under development and awaiting results of clinical trials), the report made two sets of recommendations for high risk groups. The first set comprises five initial high-risk target groups covering a total of 159-161 million Americans. The initial vaccine target groups assume adequate vaccine production to meet public demand and include the following groups: pregnant women, persons who live with or provide care for infants aged < 6 months, (e.g., parents, siblings, and daycare providers), health care and emergency services personnel, persons aged 6 months to 24 years, and persons aged 25-64 years who have medical conditions that put them at higher risk for influenza-related complications.

The second set of recommendations serve to inform vaccine providers and public health officials at the local and state level if initial H1N1 vaccine production and availability falls short of public demand. These recommendations prioritize vaccination for a subset of the initial high-risk group until additional supplies of the vaccine are made available. This subset of prioritized vaccine groups includes 42 million Americans in the following categories: pregnant women; persons who live with or provide care for infants aged <6 months; health-care and emergency services personnel who have direct contact with patients or infectious material; children aged 6 months to 4 years; and children and adolescents aged 5-18 years who have medical conditions that put them at higher risk for influenza-related complications.

Given the projections for at-risk categories for the H1N1 monovalent vaccine include individuals who comprise a large portion of university students and members of university faculty and staff, and university settings where influenza virus transmissibility increases the likelihood of contact with ill individuals; it is important to gain an understanding of the factors that influence preventive health practices such as vaccination. The population sampled for participation in the present study is largely an atypical at-risk group of healthy young adults who would not otherwise be recommended for receipt of the seasonal flu vaccine, but have increased likelihood of experiencing H1N1 infection and possible transmission to vulnerable others. Given the rationale for studying university members in the present research, the following section will discuss the theoretical framework which guides this study.

The Health Belief Model

The Health Belief Model (HBM) serves as the theoretical basis for this thesis because of its utility in explaining preventive health behaviors and the applicability of its core constructs across other theories of health behavior. The HBM began in the late 1950s as an attempt to explain the limited success of various public health promotion programs for tuberculosis screening. Since its inception, the HBM has been the theory most widely utilized for explaining health behaviors among a wide variety of populations (Conner, 2007), and its utility as an explanatory model of preventive health behaviors is well established in the health psychology literature. An in-depth discussion on the variations of the HBM and its range of applications is not within the scope of the present thesis, though the interested reader may be directed to several reviews discussing these issues (Becker & Maiman, 1975; Janz & Becker, 1984; Rosenstock, 2000). A discussion concerning the model's core constructs, however, is necessary for defining the conceptual framework of this thesis. This brief overview of the HBM constructs should provide a sufficient basis for the operationalization of risk perceptions as used in the present research.

The HBM was developed to predict participation in preventive and protective health behaviors from the following constructs, or health beliefs, regarding an individual's perceptions of the severity and susceptibility to an illness, and the benefits and barriers associated with a recommended health behavior. The HBM posits that the motivation to take protective action arises from individual's subjective perception of the level of perceived threat posed by an illness or other health hazard. Perceived threat is typically defined as a latent construct consisting of the combination of perceptions related to the severity (or seriousness) and susceptibility (or likelihood) of contracting an illness. The protective action (i.e., vaccination) is evaluated in terms of its perceived benefit (efficacy) in reducing the threat posed by the hazard (i.e., lowers susceptibility or severity). The benefits provided by a protective action should be significant enough for the individual to overcome the perceived barriers (costs or risks) associated with performing the protective action. These constructs are further defined in the following sections.

Research Variables

In the previous section, the core constructs of the HBM were reviewed in order to explain the theoretical framework of the model used to guide this thesis. In this section, the risk perception constructs are discussed in terms of their shared nature across theories of health behavior, their use in prior research on vaccination acceptance and uptake, and their operationalization for use in the present study.

Vaccine Acceptance

Acceptance or rejection of the H1N1 vaccine represents the dichotomous dependent (criterion) variable used to define outcome group membership in this research. Vaccine acceptance is indicated by stating that one plans to become vaccinated for H1N1, or is assumed for individuals who have recently been vaccinated. Vaccine accepters stand in contrast to the reference group of vaccine rejecters, composed of individuals stating that they do not intend to receive the H1N1 vaccine. This method of dichotomizing groups of vaccine accepters from rejecters has been used frequently in past research regarding hypothetical vaccines (e.g., for human immunodeficiency virus), and for vaccines that are indicated for selective use among females, but not yet among males (e.g., human papilloma virus; Brewer and Fazekas, 2007).

Previous Influenza Vaccination

The experience of university life presents young adults with the opportunity to make independent decisions about their health behaviors, including the decision to receive flu vaccines. Previous experience with influenza vaccination has been associated with subsequent vaccine uptake by elderly adults, health professionals, and individuals at-risk for serious complications of influenza infection. Additionally, previous vaccine experiences have been associated with subsequent vaccination in healthy working adults (Blue & Valley, 2002). More recently, a survey on the intentions to receive the H1N1 vaccine once it is released found that one of the strongest predictors of intentions to vaccinate for H1N1 was being vaccinated for seasonal influenza (Maurer et al., 2010). The issue of whether cognitions mediate the effects of past experience has been a central concern of researchers using the theory of reasoned action (Ajzen, 1991). However, within the constructs of the HBM, the role of prior health behavior experience is not directly addressed, and this has been one of the model's major criticisms (Conner, 2007). In a prospective study, Cummings et al. (1979) found both direct and indirect effects for past experience with flu shots upon subsequent vaccination uptake. Perceived efficacy of the vaccine and the behavioral intention construct of the theory of reasoned action were found to be partial mediators of past experience with vaccination. No study to date has assessed the influence of previous vaccine uptake among a sample of university members consisting primarily of healthy young adults with regards to attitudes towards novel influenza vaccines. Therefore, this study seeks to address this gap in the research by assessing the influence of past vaccination experience on the acceptability of the H1N1 vaccine.

In this study, past vaccination was assessed both through direct questioning of when the participant had last been vaccinated for the seasonal flu, as well as with a dichotomous measure of whether or not the individual perceived that they typically, or habitually, receive or attempt to receive the seasonal flu shot on an annual basis. To the best of the author's knowledge, the later dichotomous measure of habitual flu shot uptake has not been used in prior research scenarios, but is used as a measure of one's perceptions of the regularity of one's own past behavior, rather than the objective measure of years since the last past vaccination.

Risk Perceptions

Perceptions of risk are considered to be general predictors of preventive health practices (van der Pligt, 2001), and are central constructs shared by most theories of health behavior, including the HBM, subjective expected utility theory (Ronis, 1992), protection motivation theory (Rogers, 1983), and the theory of reasoned action (Ajzen, 1991). In a critique of the methods used to test these theories of health behavior, Weinstein (1993) provides an informative summary of the four theories of health behavior, including the shared assumptions of these theories regarding risk perceptions and their role in providing the motivation to perform preventive health behaviors. First, all assume that the motivation for self-protection arises from the anticipation of a negative health outcome and the desire to avoid this outcome. Second, they agree that the impact of a negative outcome on the motivation to act is determined in part by anticipatory beliefs regarding the expected averseness of the outcome, as well as beliefs about the likelihood an action will occur. Finally, these theories also share the assumption that the motivation to act arises from the expectation that an action can reduce the likelihood or severity of harm (perceived benefits). Despite the seemingly broad assumptions shared between these theories, the major differences between the various theoretical frameworks are regarded as differences in the number of variables included in the model; the scope, breadth, and depth of influences for each variable; and variations in the combinatorial rules dictating the order and importance of research variables in mathematical models of the theories. Each of the following risk perception variables are defined below in terms of their function in the HBM framework and include the methodological considerations regarding their assessment in this research.

Perceived Severity

Perceived severity, or seriousness, refers to the extent of harm expected to be the result of contracting influenza. Prior research on vaccination uptake has typically focused on high-risk populations that are more likely to experience influenza-related morbidity and mortality. Because healthy adults are less likely to experience severe consequences relative to contracting influenza, the relevance of using traditional approaches in assessing perceived severity among high risk individuals is of limited use for the current sample of healthy college students. In order to properly assess the full range of the negative consequences due to influenza infection, this study supplemented severity assessment items concerning the health-related morbidity and mortality beliefs with student-specific impacts on factors such as; academic performance, absences due to illness, and disruption in daily activities. These items were drawn from a series of studies on the impact of influenza-like illnesses on student populations (Nichol, D'Heilly, & Ehlinger, 2005; Nichol, D'Heilly, & Ehlinger, 2006; Nichol et al., 2008).

Perceived Susceptibility

The term *susceptibility* has been used interchangeably in the literature with *probability*, *likelihood*, and *vulnerability*, which has led to confusion and likely confounding in earlier studies that have not accounted for differences in definitional terms and appropriate means of assessment. A major methodological issue concerning the assessment of risk perceptions in cross-sectional research concerns possible confounding that can occur as a result of participants taking into account their intentions to vaccinate. Such confounding may occur when items asking participants to estimate the likelihood of experiencing a hazard do not condition such items on whether or not the respondent has or has not taken a specific protective action such as being vaccinated (Weinstein et al., 2007). Such has been noted in prior research (Brewer et al., 2007), in which some participants may take into account their intentions to perform the protective behavior, resulting in lower reported levels of perceived risks. In order to correct for the confounding influence of risk forecasting, it is recommended that researchers use conditional risk assessments in which the behavior or event linked to the outcome is specified (e.g., "What is the chance that you will get lung cancer if you smoke?"; Ronis, 1992). Conditional risk assessments are more closely related to factors incorporated in models of health behavior and have been better predictors of behavior than unconditional risk assessments (van der Pligt, 2001). In the current research, the HBM terminology of perceived susceptibility is defined as one's perception of the likelihood that one will experience a health hazard if one does not utilize a recommended health behavior (i.e., vaccination for H1N1).

Perceived Vaccine Efficacy

For a health behavior to be performed there needs to be an incentive for the individual to perform the action in terms of the benefits that are associated with the action. For this study protective benefits are operationalized as the beliefs that the vaccine will function to protect oneself from influenza infection (perceived efficacy) and reduce the likelihood of experiencing the negative events associated with becoming sick. Perceived vaccine efficacy was assessed through calculating difference scores subtracting the perceived likelihood of contracting an illness under the condition that one has been vaccinated from the perceived likelihood of infection under the condition that one is not vaccinated for each of the respective influenza vaccines. Increased values for this difference score represent decreased likelihood of infection between unvaccinated and vaccinated conditions, thus serving as a latent measure of perceived vaccine efficacy. In addition, a 5-point Likert response scale was also used that queried participants about their agreement or disagreement with a direct statement about the vaccines' protective benefits for oneself. This alternative measure was used in lieu of the latent measure because of issues in the logistic regression analysis, which is further discussed in the results chapter.

Perceived Vaccine Risks

Beliefs about the negative health effects of vaccines are prevalent in today's society, and these beliefs are undoubtedly supported by the prevalence of vaccine-negative information that is found on the internet. In a study assessing the scope of vaccine-negative information available online Zimmerman (2005) found one in every two websites containing information on vaccine practices contained negative information about vaccines. Risk perceptions concerning the negative effects of vaccines have been demonstrated to be related to both omission and commission of vaccines across such diverse groups as low income community members (Armstrong, Berlin, Schwartz, Propert, & Ubel, 2001), the elderly (Nexøe, Kragstrup, & Søgaard, 1999), healthcare workers (Canning, Phillips, & Allsup, 2005), and persons considered at high risk due to chronic health conditions (Brewer & Hallman, 2006; Brewer et al., 2004). The overall association is a strong inverse relationship between vaccination and vaccine acceptance and side effects associated with the vaccine.

The HBM states that in order for a protective behavior to be performed the benefits of the behavior should outweigh its costs. Thus, a kind of cost-benefit analysis is thought to occur wherein the individual weighs the action's effectiveness against perceptions that it may be expensive, dangerous, unpleasant, inconvenient, time-consuming, and so forth. With regard to preventive health behaviors, it is thought that the perceived barriers dimension is one of the most strongly associated components that determine whether or not a specific health behavior is enacted (Janz & Becker, 1984). In this research, perceived risks associated with receiving either of the vaccines focuses on the iatrogenic and safety concerns about the vaccines.

III: METHODS

This chapter presents the research design and methodology. Included here are descriptions of the procedures for sample recruitment, data collection, and statistical analysis used in the present study. The presentation of this chapter is divided into the following sections: research perspective and design; procedures for recruitment and data collection; development of the research instrument; methods for variable assessment; and a description of the statistical analysis procedures.

Research Perspective and Design

This cross-sectional study utilized a descriptive-comparative design for comparing existing levels of theoretically-defined risk perceptions between seasonal and outbreak influenzas among vaccine accepters and rejecters. A naturalistic research perspective was employed for comparing existing levels of risk perceptions in cross-sectional sample data collected over a two week timeframe. This timeframe coincided with the local release of the newly developed H1N1 vaccine during the initial two weeks of a university-sponsored vaccine outreach program. Individual respondent-level data is the unit of analysis for all statistical procedures; a within-subjects approach is used for comparing risk perceptions between seasonal and outbreak influenzas, whereas between-subjects analyses are employed in the assessment of factors associated with vaccine acceptance group membership status, as well as for the exploratory interaction analyses.

Methods and Procedures

Descriptions of the methods and procedures are provided in sufficient detail to allow for technical review of the methodology and replication of the study. The first objective of this research is to provide a within-subjects comparison of risk perceptions between seasonal and outbreak influenzas through direct-difference t-tests of difference scores computed between levels of perceived risks associated with seasonal and outbreak H1N1. The second objective is to assess the influence of risk perceptions and past vaccination for the seasonal flu on vaccine acceptance group membership for seasonal and outbreak influenzas through developing separate multiple logistic regression models on the outcome of vaccine acceptance for the seasonal flu shot and the H1N1 vaccine. The third objective is to explore the role of interactions between risk perceptions; the fourth objective is to assess interactions between past vaccination status and the four risk perceptions, both are tested through hierarchical logistic regression analysis procedures.

Sample Recruitment

Nonprobability sampling procedures were used to recruit a convenience sample of participants through two sources. The researcher presented all attendees of a university-sponsored vaccine outreach program with the opportunity to participate in the research project and provided potential participants with a description of the research and a copy of the informed consent document. All interested persons provided an email address on a sign-up sheet that was made available upon exit of the vaccine outreach program. A total of 44 individuals were recruited from the vaccine outreach program. A second set of participants were recruited through in-class announcements in several introductory-level anthropology and psychology courses. Interested participants submitted their email addresses on a sign-up list created by a member of the thesis committee within the university's secure server system. A total of 122 participants were recruited from the in-class announcements. A grand total of 166 questionnaires were submitted from respondents recruited from both sites. Potential participants were asked to read through the information and contact the researcher if they had any questions about the research prior to completing the questionnaire.

Research Instrument

The questionnaire used in this research was developed by the author specifically for use in the present study. The research instrument development process was informed by previous research on measures using the framework of the Health Belief Model (Janz & Becker, 1984), cross-theoretical research on risk perceptions (Brewer et al., 2007; Weinstein & Nicolich, 1993; Weinstein, Rothman, & Nicolich, 1998), and empirical research on influenza vaccination uptake among college students and healthy adult workers (Nichol, D'Heilly, & Ehlinger, 2008). Transparency of the research intent was made explicit both in the introduction to the research and within section prompts to encourage honest responses and reduce reactivity to potentially sensitive items. The term "*Swine Flu*" (capitalized, non-italicized in the questionnaire) was used throughout the questionnaire in order to distinguish between items assessing the typical "*seasonal flu*" (lowercase, also non-italicized in the questionnaire). The term "*Swine Flu*" was used to identify the H1N1 influenza in the questionnaire because of its relevance in the news media and vernacular reference to the H1N1 influenza among the general population. Items were reviewed by thesis committee members who provided feedback regarding item wording and scope of content. Two graduate and undergraduate volunteers reviewed the questionnaire for grammatical errors and made suggestions to improve the readability of individual items and section prompts. Sections differing in content and response formats were presented on separate webpages preceded by a brief prompt describing the section content and response instructions. The order of presentation for the measures was consistent across all survey administrations. Multiple items used for composite scales were presented in randomized order on each survey. Potentially sensitive items (regarding personal health conditions) and demographic information were collected at the end of the questionnaire.

Research Variables

Measures of risk perceptions were developed separately for both seasonal and outbreak influenza using matching pairs of items that assessed identical content. Attention was paid towards constructing equivalent pairs of items with regard to the valence, intensity, and key terminology between matching items for seasonal and outbreak influenza. Composite scales were formed through unit-weighed summation of scores for seasonal and H1N1 influenza separately. Prior to summation, response values on reversed items were recoded so that increasing scores reflect increases in the value of the underlying construct. Internal consistency reliability estimates (Cronbach's alpha) were calculated for items used for summative scales for the constructs of perceived severity and perceived vaccine risks. Matched pairs of items were deleted simultaneously if their exclusion resulted in an overall improvement in the measure's internal-consistency reliability. Items were not deleted if they were judged to be essential towards assessment of the construct. Cronbach's alpha of .80 or above is considered good reliability for social sciences research (Cohen, 1983). All items used in the survey may be found in appendix A.

Outcome: Vaccine Acceptance Group Membership

The outcome of interest in this study is vaccine acceptance group membership, which was assessed separately for both the seasonal and H1N1 vaccines for each of the respondents. Respondents were categorized as members of the vaccine acceptance group (coded 1) for each type of influenza if they indicate that they have already received the vaccine, or if they have not yet been vaccinated but are planning to do so within the next two weeks. In contrast, a respondent is categorized as a vaccine rejecter (reference group, coded 0) for each type of influenza if they have not been vaccinated and indicate they do not plan to receive the flu shot or the H1N1 vaccine. Of the 158 respondents with complete data, 58 (36.7%) accepted the H1N1 vaccine and 70 (44.3%) accepted the seasonal flu shot, whereas 100 respondents rejected the H1N1 vaccine and 88 rejected the seasonal flu shot.

Perceived Severity

Items assessing the perceived severity or seriousness of the consequences of experiencing an influenza infection on one's health, academic performance, and lifestyle outcomes were drawn from studies assessing the impact of influenza-like illnesses on student populations (Nichol et al., 2008) and a study of vaccine acceptance among healthy adult workers (Blue and Valley, 2002). Examples include "*Getting the Swine Flu could prevent me from completing my school or work assignments*" and "*Getting the Swine Flu would make me sick enough to go to the hospital.*" Participants indicated their level of agreement on 5-point Likert response scales. Verbal anchors on response scales ranged from *strongly disagree* (scored 1) to *strongly agree* (scored 5). Five items were summed for both seasonal and outbreak influenza to create a composite perceived severity scale with possible scores ranging from 5 to 25, with increasing scores on these scales representing increased severity of consequences of contracting each type of influenza. Scores on the perceived severity scales evidenced good internal consistency reliability for both outbreak and seasonal influenza (Cronbach's α = .867 and .834, respectively).

Perceived Likelihood of Infection if Not Vaccinated

Perceived likelihood of infection is defined as the subjective perception of the likelihood that one will experience a health hazard under the condition that one does not take the recommended health action (is not vaccinated). Two items are used to assess the perceived likelihood of infection for seasonal and outbreak influenza separately. A 7-point verbal risk magnitude scale (Weinstein et al., 2007) was used to assess perceived likelihood. The verbal response options (and response scores) are the following: *almost zero* (score = 1), *very small* (2), *small* (3), *moderate* (4), *large* (5), *very large* (6), and *almost certain* (7). Responses on the item assessing one's perceived likelihood of infection under the condition of not being vaccinated represent the level of perceived susceptibility to H1N1 given that one has not been vaccinated. Increases in this score represent increased perceived likelihood of becoming infected.

Past research utilizing self-reported assessments of one's perceived likelihood of infection has been highly suspect to confounding without controlling for participants' plans or intentions to vaccinate at a later time (Weinstein & Nicolich, 1993). Without controlling for intentions to vaccinate, some participants who are not currently vaccinated might take into account their intentions to and report lower risk likelihood (susceptibility) scores. In order to control for the confounding influence of intentions to vaccinate, items assessing the likelihood of contracting influenza were first presented using a conditional unvaccinated format, and then a second time under the conditional vaccinated format. The latter assesses the perceived risks given that one has taken protective action, a risk perception that is rarely reported in the literature but is considered by some as a valid construct in the decision-making process to perform a recommended health behavior (Brewer et al., 2007). In this research, the perceived likelihood conditioned on being vaccinated is used in the calculation of perceived vaccine efficacy score, as discussed below.

Perceived Vaccine Efficacy

The intended medical function of any vaccine is to reduce the likelihood of contracting an illness through exposing one's immune system to a disabled form of the virus in order to build an immunological response for later exposures to the live virus. Perceived vaccine efficacy refers to the subjective perception of the vaccine's ability to reduce one's likelihood of contracting the illness. Perceived vaccine efficacy is a difference score computed by subtracting each participant's perceived likelihood score (representing the perceived likelihood of infection under the condition that one is not vaccinated), from their score indicating the perceived likelihood of infection under the condition that one has received the vaccine. The resulting difference score represents an indirect measure of participants' perceptions of the vaccine's efficacy in terms of its capacity to reduce the likelihood of becoming ill. Perceived vaccine efficacy was calculated separately from scores for seasonal and outbreak influenzas. Because only a single value is used to represent the construct, no reliability data is able to be calculated. However, the correlation of the perceived vaccine efficacy difference score with items drawn from a scale that is not used in the present analysis (representing level of agreement using a 5-point Likert-type scale identical to the perceived severity response options with the statement "*the flu shot [H1N1 vaccine] is effective in protecting me from infection*") evidenced a strong positive relationship between the vaccine efficacy difference score and level of agreement for both outbreak $r = .48$ ($p < .001$) and seasonal $r = .57$ ($p < .001$) influenza vaccines.

Perceived Vaccine Risks

In this study, perceived vaccine risks are assessed in terms of respondents' level of agreement with a series of five statements regarding the safety of each vaccine ("*I am concerned about the safety of the seasonal flu shot*"); concern about the contents of the vaccine ("*I am concerned there is something in the Swine Flu vaccine that I don't know about*"); possible health risks associated with the vaccine ("*The Swine Flu vaccine can have serious side effects*"); and iatrogenic effects of the vaccine ("*The Swine Flu vaccine can give me the flu*"). Responses were made on 5-point Likert-style response scales that ranged from *strongly disagree* (scored 1) to *strongly agree* (scored 5). Scores for individual items were summed to compute a scale of overall perceived vaccine risks with a possible range from 5 to 25, with increasing scale scores indicating increases in overall perceived risks associated with the vaccine. Internal consistency for items used to construct the perceived vaccine risks scale was good for outbreak and seasonal influenza (Cronbach's α = .91 and .88, respectively).

Past Flu Shot Uptake

When a behavior is repeated, as in the annual influenza vaccination, perceptions may change over time to become consistent with past action, so that the direction of causation is unclear even in a prospective design. For this reason, first-time vaccination against an illness may be the best indicator of the strength of causation (Weinstein, 2004). Previous acceptance of the vaccine is likely to predict future acceptance, either because past behavior represents a summary of perceived risks and benefits or because it represents a habit or routine (Chapman & Coups, 1999). In terms of the HBM, the influence of various health beliefs and risk perceptions are likely moderated by past behaviors or experiences. It is this last precept that will be tested in this research through the exploration of moderation between risk perceptions and past flu shot on acceptance of both the seasonal flu shot and the H1N1 vaccine. Whether or not the participant typically received the seasonal flu shot was indicated by a positive response to the item: *do you usually get (or try to get) the seasonal flu vaccine almost every year*? Positive responses were coded 1 (otherwise 0), indicating that the respondent intends to receive the seasonal flu shot on an approximately consistent annual basis.

Demographic Variables

Participants' demographic information was collected at the end of the survey. Data was collected for the following variables, discussed in greater detail below: age (in years); race/ethnicity; gender; level of education; income; employment status, whether or not they worked in healthcare, or with children or the elderly, and if the H1N1 vaccine is recommended by their employer; and if they lived with children under 6 months, elderly persons, or others who are susceptible to influenza.

Sample Characteristics

Of the 166 surveys initially submitted, eight participants did not complete at least 25% of the survey and were excluded from the analysis. Overall descriptive statistics of the sample (n = 158) and the reference codes for categorical data used in the logistic regression are reported in the following text.

Age. Respondents reported their age in years. The sample age ranged from 18 to 51, with an overall sample mean of 24.1 (SD = 8.6). Age was also used as a dichotomous variable based on the CDC's recommendations for individuals under the age of 25 to receive the vaccine (age < 25, coded 0; ≥ 25, coded 1). Of the 158 respondents with usable data, 117 (74%) were under 25 years of age and considered a target group for vaccination according to the CDC's recommendations for H1N1 vaccination.

Gender. The sample consisted of 51 (32.3%) males (coded 1) and 107 (67.7%) females (coded 0).

Education. The majority of the sample (86.7%) consisted of undergraduate students (3.8% were first-year college freshmen), whereas the remainder of the sample (13.3%) were graduate students or had already obtained their Bachelor's degree. Education was dichotomized into groups demarcated by those who had completed their first two years of college education (lower-division, coded 0) and those who have completed more than two years of college (upper-division, coded 1).

Ethnicity. Race/ethnicity information was collected through two items used by the university for collection of student demographic information; the first asked respondents whether or not they were of Hispanic/Latino/Central or South American origin (referred to as Latino), and a second item asked participants to select as many categories that apply (Caucasian/White, African American/Black, Asian/Pacific Islander, and Native American/Alaska Native). Individuals selecting two or more categories in the second item were classified as multiracial. The sample was composed of 71.3% (112) White; 12.1% (19) White-Latino; 8.9% (14) Latino; 5.1% (8) Black, non-Latino; 1.3% (2) for both Asian and Multiracial categories. Due to restrictions in the sampling dispersion for all categories other than White, race was dichotomized into White (coded 0) and non-White (coded 1) categories.

Employment. One item assessed employment status. Unemployed participants made up about one-fifth (20.3%) of the sample, 93 participants (58.8%) had part-time employment, 17 (10.8%) were employed full-time, and 16 (10.1%) were currently volunteering or had internship placements. Employment was dichotomized into unemployed (coded 0), and all other categories (coded 1).

Income. Although income data was collected through asking the respondents to mark their response to an estimate of their annual income, the majority of respondents (39.9%) either chose not to answer the item or indicated that they did not know. Of the remaining participants who responded to this item, 14 (8.9% of the responses) made less than $10,000, 23 (14.9%) made between $10,000 and $25,000, 29 (30.5%) between $25,000 and $50,000, and 29 (30.5%) reported income higher than $50,000. Because of the large proportion of nonresponse, the income variable is not used in the analysis.

Objective Health Risks. Participants indicated whether or not they have been diagnosed with at least one health condition from a list of all possible conditions the CDC recommends for influenza vaccination due to increased health risks of complications of infection. Respondents indicating that they had at least one health condition were coded 1; other responses were coded 0. None of the respondents indicated that they have a severe allergy to eggs or other medical contraindication towards receiving vaccines.

Proximity Risk. Respondents who live or work with young children, elderly individuals, or persons in frequent contact with persons with objective health risks to influenza (mentioned above) were classified as members of a proximity risk group (coded 1, otherwise 0), presenting a possible risk of influenza transmission to vulnerable others.

Data Collection Procedures

Data collection occurred over a period of two weeks between the 14th and 24th of December 2009, and coincided with the university's H1N1 vaccine outreach program. Participants completed the anonymous online questionnaire over an SSL-encrypted webpage. Participants who submitted their email addresses were sent a link to the research instrument within 24 hours of registration and were instructed to complete the online questionnaire by themselves at their nearest convenience. All available addresses were sent an email that included a copy of the consent form, a unique survey identification number, and a link to the online questionnaire instrument. Participants were instructed to enter the unique identification numbers on the first item of the questionnaire as an acknowledgement of informed consent. Reminder emails were sent to non-respondents on the following Wednesdays and Fridays for two weeks unless they chose to opt-out of the emails. Potential participants recruited from the classroom recruitment site were offered a small amount of extra-credit for their participation. All survey respondents' unique identification numbers were entered into a lottery to be randomly selected to win a $20 gift certificate for both the initial survey, as well as an anticipated follow up (later excluded from the analysis due to poor response rate). All participants were over the age of 18 and provided consent for participation at the beginning of the survey questionnaire. The procedures of this study were approved by the institutional review board of Texas State University-San Marcos.

Participants were instructed to complete the survey in a location with sufficient privacy to encourage honest and anonymous responses to items containing potentially sensitive information. The use of internet-based surveys provides a convenient and minimally intrusive method for participants to submit survey response data. The online survey software system Surveymonkey (Finley, 2009) was used as the template for constructing the surveys and as the primary method for collecting survey data. Ten participants from the vaccine outreach program recruitment site requested and received a paper-and-pencil survey to submit their responses on-site, and their data were entered manually by the researcher into the electronic dataset. All survey data were visually inspected for incomplete surveys prior to transferring the data to SPSS version 17 (SPSS Inc., Chicago) for statistical analysis.

Statistical Analysis Procedures

The following statistical analysis procedures were used to test the research hypotheses of the present study. All statistical analyses were performed using SPSS version 17 (SPSS Inc., Chicago, Il.).

Missing Values, Composite Scales and Transformations

Prior to forming the composite scales, reverse-worded items were rescored so that increasing values of the responses for all items reflect an increase in the underlying construct. Missing data patterns were assessed for deviation from random by obtaining *Little's Missing Completely At Random (MCAR) test* (Little, 1988). Nonsignificant results of Little's MCAR test indicate that the pattern of missing values does not depend on the data values. Missing values on numerical items were imputed using the outcome-group weighted mean value for the item. Outcome group weighted mean substitution is generally preferred when analysis focuses on comparing differences between groups as it does not affect the grouped means; however, this procedure does artificially reduce the standard deviations of the measures within outcome groups (Tabachnick & Fidell, 2001). Composite scales were computed by unit-weighed summation of raw scores for items used in scales representing perceived severity and perceived vaccine risks. Individual items were considered for exclusion from the composite scale in order to increase internal consistency reliability of the overall measure if the item was not considered critical for the scale content validity. Matching pairs of items between seasonal and outbreak influenza scales were removed pairwise to ensure that similar risk perception characteristics were used for scales between seasonal and outbreak influenzas.

Comparison of risk perceptions between seasonal and outbreak influenza

In order to test for differences in risk perceptions between seasonal and outbreak influenzas, paired-samples t-tests were used to analyze differences in mean levels of perceived risks for both seasonal and outbreak H1N1 influenza types across respondents. The null hypotheses tested state that there are no differences in mean levels of the four risk perceptions (perceived severity, perceived susceptibility, perceived vaccine efficacy, and perceived vaccine risks) between identical measures of perceived risks for seasonal and outbreak H1N1 influenzas. Nominal alpha for detecting significant differences was set at $p \leq .05$ for the analyses.

Factors associated with vaccine acceptance group membership

Sequential logistic regression models are used to predict vaccine acceptance group membership, first from the influence of the four risk perception (continuous, mean-centered), then after the addition of past flu shot uptake (dichotomous). The overall null hypothesis states that the model containing predictor coefficients does not predict vaccine acceptance better than the null model containing none of the predictors. This is tested through use of the likelihood ratio test of the overall model (χ^2_{model}), distributed approximately as a chi-square distribution with degrees of freedom equal to the number of predictors included in the model. The influence of adding habitual past flu shot uptake behavior is assessed through using the likelihood ratio test between blocks (χ^2_{block}), also assumed to be distributed as approximately chi-square. Providing that the overall model or block is statistically significant, individual predictors are assessed through the *Wald's* statistic. The summary goodness-of-fit measure for logistic regression models that contain continuous predictors is the *Hosmer-Lemeshow deciles of risk* (H-L) test, with nonsignificant results indicating that the model fits the data well (Hosmer & Lemeshow, 2000).

Exploratory Interaction Assessments

Interaction terms are formed through computing the multiplicative product term between two variables (Jaccard, 2001). Multiple interactions of the same order are tested simultaneously in an additional step of the logistic regression model. Nontrivial differences are indicated by a statistically significant reduction in overall deviance assessed through the likelihood ratio test between nested models. As with the tests for the significance of adding predictors to the model, statistical significance is indicated by significant overall χ^2 for the block of predictors. However, nonsignificant interaction terms are removed from the analysis for sake of parsimony and the model is re-run with only significant interaction terms to produce the final logistic regression parameter estimates. All interaction analyses are exploratory due to the small sample size obtained for the final analysis and restrictions of the number of predictor variables that may be included in the model.

Logistic Regression Assumptions and Diagnostics

Though logistic regression requires fewer assumptions than other regression techniques, critical data considerations remain that potentially could preclude the accuracy of the results. This section discusses the critical issues in logistic regression analysis covered by Tabachnick and Fidel (2001), Hosmer and Lemeshow (2000), and Jaccard (2001) which are taken into account when conducting a binary logistic regression analysis.

Numerical issues

Numerical issues for logistic regression analysis such as multicollinearity, singularity, and quasi-complete separation are primarily detected through inspection of estimated logistic parameters to identify unstable iterations, inordinately large (or small) logistic coefficients and standard errors, or through warnings from a failed run of the logistic regression model. Numerical issues are largely avoided in the current analysis by dichotomizing categorical predictors and ensuring that contingency tables for all discrete variables, including the binary dependent, ensuring that cross-tabulations between categorical variables fulfill basic chi-square assumptions of expected cell frequencies. Specifically, no cell has an expected frequency less than one, and less than 20% of all cells have expected frequencies less than five (Hosmer & Lemeshow, 2000).

Linearity in the logit of continuous predictors

Logistic regression analysis requires a linear relationship between continuous predictors and the logit (log odds) of the binary dependent variable (Hosmer & Lemeshow, 2000). Such nonlinear relationships may be detected through the *Box-Tidwell test of nonlinearity in the logit* (Tabachnick & Fidell, 2001). This approach adds to the logistic regression model a set of interaction terms consisting of the multiplicative interactions between the continuous predictor and its natural logarithm. A significant ($p \leq .05$) *Wald* χ^2 result for any of the Box-Tidwell interaction terms suggest that there is a violation of the assumption of linearity in the logit for the variable. Violations of the assumption of linearity in the logit are analogous to the violation of the assumption of linearity in linear regression and typically result in lowered power and increased risk of Type II error.

Ratio of cases to variables

As in linear multiple regression using ordinary least squares (OLS), the sample size limits the number of predictors that may be included in the analysis before overfitting becomes an issue. Overfitting is an issue encountered when the predictors in the model are found to be significant by virtue of idiosyncratic patterns in the data (Hosmer & Lemeshow, 2000). An inadequate ratio of cases to variables may cause a failure in the logistic model to reach convergence, or may produce inordinately large standard errors and parameter estimates when pairs of discrete variables contain empty cells with no cases. The minimum ratio of 10 cases per independent variable is observed when reporting results of the models.

Adequacy of expected frequencies

Goodness-of-fit statistics may have little power if the expected frequencies between pairs of discrete variables (including the binary dependent) are too small to allow for appropriate estimation of predicted frequencies. As discussed earlier, cross-tabulations are conducted for each pair of discrete variables in order to evaluate the expected frequencies between pairs of discrete variables. If all expected frequencies are greater than 1, and no more than 20% have expected frequencies less than 5, then it is assumed the sampling distribution of frequencies is sufficient to permit the use of chi-square goodness-of-fit statistics that compare expected and predicted frequencies (Tabachnick & Fidell, 2001).

Absence of separation

Complete separation exists when a discreet variable perfectly predicts group membership based on concomitant representation of a single value for a variable by all members of the outcome group. A similar issue of partial separation exists when only one case is representative of an outcome group for a given response. Both partial and complete separation scenarios cause instability in the model that precludes accurate estimation of the logistic parameters. Both partial and complete separation are indicated by a failure of the logistic regression model to converge, or are otherwise indicated by unstable estimates of model parameters and inordinately large standard errors (Tabachnick & Fidell, 2001).

Absence of multicollinearity

As for all varieties of regression procedures, logistic regression is sensitive to high correlations among the predictor variables. Therefore, colinearity diagnostics were assessed through a multiple regression of all variables on the DV test for indicators of multicollinearity. Although there are no established rules for assessment of collinear relationships, the recommended indicators of acceptable colinearity include a variance inflation factor (VIF) statistic ($< .4$) and tolerance ($>.1$) (Tabachnick & Fidell, 2001).

Casewise Assessments of Fit

Three sets of statistics are recommended for the purpose of detecting individual cases that do not fit the model well (Hosmer, Taber, & Lemeshow, 1991). The three diagnostic statistics and the syntax code for calculating each from saved values (requested in SPSS) are calculated as follows:

Delta chi-square ($dchi^2$) = $zresid^2$ / (1-leverage)

Delta deviance (ddev) = ($deviance^2$ + $zresid^2$ * leverage) / (1-leverage)

Delta standardized beta (dsbeta) = $((zresid/sqrt(1\text{-}leverage))^2$ * leverage) / (1-leverage)

Where the values of zresid represent the standardized residual of the predicted values; deviance is a residual value based on log-likelihood values; and leverage is a measure of influence of an individual case that depends on weights based on the estimated logistic probability and on the distance of an observation from the mean of the predictor. All the above calculated values are indicators of the effect of removing each individual case from the model. Plots of these three diagnostic variables against predicted probabilities are presented as visual diagnostics of casewise lack of fit and influence on model parameters. These plots are similar to plots of residual values against predicted probabilities in OLS regression. Individual cases exhibiting poor fit to the model or undue influence on the estimates of model parameters are identified and censored in exploratory runs of the final logistic regression models to determine if these cases cause undue influence on model estimates.

Overview of Methods for Model Development and Statistical Analysis

Patterns of missing values are assessed and numerical values are imputed prior to the summation of composite scales. Direct-difference *t*-tests are conducted to determine if risk perceptions differ between seasonal and outbreak influenzas and their vaccines, respectively (objective 1). Two separate sequential logistic regression models are developed in order to test the remaining research objectives. In the first step of each logistic regression, confirmatory hypotheses concerning the relationships between each of the risk perceptions with vaccine acceptance are tested to establish whether the four risk perceptions are related to vaccine acceptance among the present sample of university members. Evaluations of the associations of individual risk perception predictors and past flu shot are assessed in sequential analysis while controlling for the effects of the risk perceptions (objective 2). Odds ratios of the effect of the predictor are judged to be reliable estimators of the effect under similar testing conditions within similar samples if the 95% confidence interval estimates around the odds ratios do not contain the value of 1 within its upper and lower bounds. Final evaluations of the statistical significance of individual predictors are assessed in the final logistic regression models after adjusting probability values for family-wise inflation of Type I error rate for including multiple predictors in the analysis.

The second step of each regression model tests exploratory research hypotheses that include possible interactions between risk perceptions (objective 3) and between past flu shot uptake status and the risk perceptions (objective 4). Interactions among risk perceptions constructs are assessed after forming an interaction product term of the standardized (z-scored) values of the risk perception predictors. Interactions at the same level are assessed simultaneously and nonsignificant effects are “trimmed” from the analysis for sake of parsimony. Because the presence of a significant interaction takes precedence over confounding when interpreting the effects of an independent predictor variable, the possible role of past habitual flu shot habit as a confounder of the relationships between risk perceptions and vaccine acceptance will be assessed only in the absence of significant interactions. Therefore, prior to the assessment of possible confounding a third set of exploratory hypotheses are tested to assess for possible effect modification (moderation) interactions between risk perceptions and status regarding past flu shot uptake (objective 4). In order to test for possible moderation, an interaction term is formed by calculating the multiplicative product between the dichotomous predictor (Past Flu Shot) and each of the four mean-centered risk perception predictors. Significant results of the interaction terms representing moderation effects between past flu shot uptake and the risk perceptions signify that the association of a given risk perception on vaccine acceptance is conditionally dependent on the respondent’s past flu shot status (i.e., whether or not they typically receive or try to receive the seasonal flu shot each flu season). Thus, the association between the risk perception and vaccine acceptance is significantly different for those who report that they typically vaccinate for the seasonal flu compared to those who report that they do not typically receive the seasonal flu shot.

Exploratory hypotheses concerning the theoretically-defined interaction between perceived severity and perceived susceptibility, as well as between perceived vaccine efficacy and perceived vaccine risks are tested prior to interpretation of the main effects of each of the predictors. Prior to entry into the logistic regression model, interaction terms are calculated as the multiplicative product of the standardized *z*-score transformations of the two predictors. The use of z-scored units is used in light of the different response ranges of the predictors, thus allowing the results of the interaction to be interpretable in terms of standard deviation scaled differences rather than the arbitrary units of measurement used by the original measures.

Significance tests of the influence of predictors and interactions are assessed in the same manner and at the same level of significance as tests of individual predictors. That is, each individual predictor (either an interaction term or independent variable) is assessed for significance according to the *Wald* χ^2 single degree-of-freedom test, which is verifiable through likelihood ratio tests comparing negative two log likelihood values between the full model and a nested model without the predictor. Odds ratios are used for interpretation of predictor effects as well as measures of the effect size of statistically significant predictors. Upper and lower bounds of the 95% confidence intervals around the odds ratios provide an indication of the precision of the estimated change in odds due to a unit change in the predictor. Confidence intervals containing a value of 1 within the upper and lower 95% bounds indicate that the variable is not a reliable predictor of the outcome for the present data.

All four risk perceptions and past flu shot predictors are retained in the logistic regression analysis regardless of their statistical significance. However, nonsignificant interaction terms are removed from the final logistic regression model for sake of parsimony, as well as to preserve degrees of freedom and maintain reliable estimates of standard errors in the final model. As stated earlier, confounding will be assessed for habitual flu shot status only after possible interaction with other terms has been ruled out.

Assessment of confounding is performed through inspecting changes in odds ratios of variables in the equation as possible confounders are entered or excluded from the model. An arbitrary value of 25% change in the odds ratios is chosen as the criterion for determining that a variable has substantial confounding influence on another variable's odds ratio as the confounding variable is added to or removed from the model. Assessments of poor fit and influence of individual cases are assessed through constructing plots of residual values.

Results from the final logistic regression models predicting acceptance of the seasonal flu shot and the newly developed H1N1 vaccine are presented in table format at the conclusion of the results chapter. Overall model evaluations include the *Hosmer and Lemeshow deciles of risk test* (HL), which is the recommended goodness-of-fit test for models containing continuous predictors and small samples, and omnibus tests of the overall model through both model and block χ^2 results. Nonsignificant results of the HL deciles of risk test are interpreted as an indicator that the model significantly fits the data. Interpretations of the effects for independent variables are made according to the results of the final fitted logistic regression models. Results are reported according to the guidelines recommended by past researchers (Peng & So, 2002). Interactions are assessed, reported, and interpreted according to recommendations from Jaccard (2001).

IV: RESULTS

This chapter presents the results of the statistical analyses in six sections. The first section presents the preliminary data screening procedures, and empirical distributions of the research variables. The second section responds to the research question concerning differences in perceived risks between seasonal and outbreak H1N1 influenzas by presenting the results of the within-subjects analysis of risk perceptions between the two flu types (objective 1). The third section presents the findings relevant to the logistic regression model development process and model diagnostics in response to the research question concerning factors associated with vaccine acceptance group membership for the seasonal flu shot and H1N1 vaccines in separate analyses (objective 2). The fourth section presents results of the exploratory analyses of interaction effects between risk perception predictors pertaining to influenza (likelihood and severity) and its vaccine (efficacy and risks), separately for models predicting acceptance of each of the vaccines (objective 3). The fifth section presents the exploratory analysis of effect modification (i.e. moderation) between each of the risk perception constricts and past flu shot use to determine whether the effects of risk perceptions are differently associated with vaccine acceptance group membership between those who typically vaccinate for the seasonal flu compared to those who do not typically receive the seasonal flu shot (objective 4). The final section summarizes the findings of this chapter and presents the final logistic regression models for both seasonal flu shot acceptance and acceptance of the H1N1 vaccines, as well as offers an interpretation of the findings.

Preliminary Analysis

Missing Data

A total of 166 surveys were collected from 273 unique email addresses (60.8% response rate) submitted by students and staff of the university who were recruited through in-class announcements or upon exit of the H1N1 vaccine outreach campaign event. A visual inspection of the initial dataset identified eight surveys with missing data on at least 15% of the items, including all demographic information collected on the final page of the questionnaire. These eight surveys were removed from the dataset due to excessive missing responses; thus the sample size reported throughout is N = 158. Complete response data was collected from 141 respondents after removing the item measuring income, as 40% of the sample reported that they "*choose not to respond*" or "*don't know.*" Missing values for 17 respondents did not deviate from a pattern of randomness according to the nonsignificant results of *Little's MCAR test* χ^2 (639) = 695.791, p = .059). Due to the limited sample size and complete data requirements for logistic regression analysis, 44 missing values on numerical items were imputed using the estimated mean item values calculated from the available scores within the respondent's respective outcome group. Means and standard deviations obtained for scores on the research variables are presented in the margins of Table 1.

Vaccine Acceptance Group Membership

The dichotomous outcome variable of interest in this study, vaccine acceptance group membership, consists of respondents who are already vaccinated as well as individuals who are not yet vaccinated but intend to do so. In order to test the presumption that the two groups are equivalent on measures of perceived risks, independent samples t-tests were employed to test for mean differences among the four continuous risk perception measures between already vaccinated respondents (33 for H1N1 vaccine and 49 for the seasonal flu shot) and those who intend to be vaccinated (25 for H1N1 and 21 for the seasonal flu shot). Results obtained from the independent samples t-tests suggest that mean levels of perceived risks associated with vaccines are significantly lower among vaccinated respondents than those who intend to receive the H1N1 vaccine (t = -2.86 (56), p =.006), as well as for the seasonal flu shot (t = -2.15 (68), p = .035). For both seasonal and H1N1 influenzas, individuals who were already vaccinated had lower mean levels of perceived risks associated with the vaccine than persons who were not yet vaccinated but intended to receive the vaccine. Implications of this finding are discussed in further detail in the next chapter. Vaccine intenders and vaccinated respondents did not differ on any of the other risk perception variables and were aggregated into the outcome groups representing the H1N1 vaccine acceptance group (n = 58), and the seasonal flu shot acceptance group (n = 70).

Respondent Characteristics

The final sample of 158 cases available for analysis consisted of 100 vaccine rejecters and 58 vaccine accepters for the H1N1 vaccine, whereas 88 rejected the seasonal flu shot while 70 were classified as seasonal flu shot accepters. The sample was primarily female (67%), white (70.9%), unemployed (79.7%), undergraduate students (86.7%), and under 25 years of age (80.4%). Regarding the groups recommended by the CDC to receive the seasonal flu shot, 23 (14.6%) reported having a health condition that would place them at an increased risk of complications related to an influenza infection, and 68 (43%) reported being in close contact with another at-risk individual. As for the additional H1N1 vaccine-recommended group of adults under the age of 25 initially proposed by the CDC for priority receipt of the H1N1 vaccine, 117 (74.1%) were between 18 and 24 years-old. Concerning respondents' perceptions about past seasonal flu shot uptake, 53 (33.5%) reported that they typically vaccinate (or attempt to vaccinate) for the seasonal flu every year.

Summary of Preliminary Analyses

Missing values on 44 numerical items were imputed using the mean value for the item for the respondent's respective outcome group. Supplementary preliminary analysis procedures are found in appendix A. Model diagnostics are presented in appendix B.

Risk Perceptions for Seasonal and H1N1 Influenzas (Objective 1)

Table 1 presents the bivariate correlation matrices of zero-order correlations between measures. Cells above the diagonal represent correlations among predictors assessed for seasonal flu, whereas cells below the diagonal represent correlations among predictors assessed for outbreak H1N1 influenza. Cells on the diagonal represent correlations between measures of the same construct between H1N1 and seasonal influenzas. Because of the varying levels of measurement among the research variables the following correlation coefficients are used: Phi coefficients (ϕ) represent correlations between pairs of dichotomous variables (vaccine acceptance and habitual flu shot); Spearman rank-order correlations (r_{sp}) for correlations incorporating single-item measures (perceived likelihood and perceived vaccine efficacy); and Pearson correlations (r) between multiple-item summative scales (perceived severity and perceived vaccine risks).

Table 1. Bivariate Correlation Matrix of Measures for Seasonal and H1N1 Influenza Risk Perceptions

	Flu Shot Acceptance	Likelihood Flu	Severity Flu	Flu Shot Risks	Flu Shot Efficacy	Past Flu Shot	H1N1 M	H1N1 SD
H1N1 Vaccine Acceptance	.72***	.48***	.24**	-.43***	.44***	.55***	.37	.48
Likelihood H1N1	.45***	.76***	.25**	-.30***	.37***	.34***	3.01	1.13
Severity H1N1	.27***	.27***	.84***	.04	.20**	.03	17.69	4.34
H1N1 Vaccine Risks	.44***	-.23**	.04	.83***	-.61***	-.44***	14.33	4.61
H1N1 Vaccine Efficacy	.45***	.33***	.19**	-.61***	.73***	.41***	3.39	.94
Past Flu Shot	.49***	.26**	.10	-.37***	.33***	na	.34	.47
Seasonal Flu	M	.44	3.23	16.77	13.60	3.49		
	SD	.50	1.29	3.97	4.31	.94		

Note: **$p < .01$, ***$p < .001$. Correlations above the diagonal represent the seasonal flu, outbreak H1N1 correlations are below the diagonal. Bold cells in the diagonal represent correlations between seasonal and outbreak influenza; Phi coefficient for dichotomous vaccine acceptance; Spearman rank-order correlation for perceived likelihood and perceived vaccine efficacy (agreement); Pearson's correlations for perceived severity and perceived vaccine risks. Means and standard deviations for measures pertaining to H1N1 are found on the two far right columns; for the seasonal flu on the bottom two rows. N = 158 for all correlations.

The first research question (objective 1) asks whether the sample perceived different levels of risks between the seasonal and outbreak H1N1 influenzas. In order to answer this question, four paired-samples (direct difference) *t*-tests were conducted to assess for differences in mean levels of risk perceptions between seasonal and H1N1 influenzas across the entire sample. An additional comparison was included for both methods of assessing perceived vaccine efficacy. Direct difference *t*-tests are essentially an analysis of the change scores of risk perceptions between flu types by subtracting the value obtained for a perceived risk measure pertaining to the seasonal flu (or its' vaccine) from the value of the risk perception measure obtained for H1N1 influenza. The null hypothesis tested for each comparison states there will be no differences in mean level of perceived risks between seasonal and outbreak influenza. All significance tests used two-tailed significance tests and Bonferroni-corrected nominal alpha (p = .05/4 = .0125) to compensate for inflation of type I error for each of the four risk perception comparisons. Table 2 presents the results of the paired-samples *t*-tests for differences in mean levels of risk perceptions between outbreak and seasonal influenzas.

Table 2. Paired Samples Tests of Mean Differences in Perceived Risks between Seasonal and H1N1 Influenzas

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Perceived Likelihood H1N1 – Perceived Likelihood Seasonal Flu	-.23	.82	.07	-.36	-.10	-3.49	157	.001
Pair 2	Perceived Severity H1N1 – Perceived Severity Seasonal Flu	1.69	2.77	.22	1.26	2.13	7.69	157	<.001
Pair 3	Perceived H1N1 Vaccine Risks – Perceived Seasonal Flu Shot Risks	.73	2.58	.21	.39	1.14	3.57	157	<.001
Pair 4	Perceived H1N1 Vaccine Efficacy – Perceived Seasonal Flu Shot Efficacy	-.09	.64	.05	-.19	.01	-1.88	157	.06

Results of the direct differences *t*-tests indicate that there were several significant differences in mean levels of perceived risks between influenza types. The sample reported, on average, significantly smaller chance of becoming infected by the H1N1 virus than the seasonal flu ($t = -3.49$, $p < .0125$). The perceived seriousness of the consequences were significantly more severe for the H1N1 virus ($t = 7.69$, $p < .001$). Regarding differences in perceptions of the vaccine, the risks associated with vaccination were greater for outbreak H1N1 influenza vaccine ($t = 3.57$, $p < .001$). However, there were no observed differences in mean levels of perceived efficacy between the two vaccines.

The results of the within-groups analysis of risk perceptions between influenza types indicate that the sample perceived a lesser likelihood of becoming infected with H1N1, but that being infected with H1N1 was significantly more serious than the seasonal influenza. Comparisons between perceptions of the vaccines also indicate that the newly developed H1N1 vaccine was perceived as having significantly more risks than the seasonal flu shot. However, there were no significant differences observed between mean levels of perceived efficacy of the vaccines.

Multiple Logistic Regression Models of Vaccine Acceptance (Objective 2)

Factors Associated with H1N1 Vaccine Acceptance

The second research question (objective 2) asks what factors are associated with acceptance of the H1N1 vaccine. A sequential logistic regression was used to predict the binary outcome of vaccine acceptance group membership for H1N1 influenza, first from the four risk perceptions, then after the addition of past flu shot status. Past flu shot status was assessed on the second step of the regression analysis in order to assess its possible role as a confounding variable after controlling for the HBM defined risk perceptions entered on the prior step. The first block of predictors includes the four mean-centered measures of risk perceptions regarding H1N1 influenza (perceived severity and perceived susceptibility) and the H1N1 vaccine (perceived vaccine efficacy and perceived vaccine risks). The second block adds the dichotomous indicator variable distinguishing between respondents who typically receive the seasonal flu shot on an annual basis from those who report that they do not typically receive the seasonal flu shot.

The null model correctly classifies 63.3% of the participants solely on the basis of membership in the largest proportional outcome group of vaccine rejecters ($n = 100$). The negative two log likelihood of the intercept-only model ($-2LL_0 = 207.735$) serves as the baseline for assessing improvements in fitted regression models. Improvement of the model is also assessed in terms of the final model's proportional reduction in error classification rate over chance alone, with chance classification defined conservatively as the rate of correct classification due to membership in the largest proportional outcome. A 25% improvement in overall correct classification from chance establishes the criterion for adequate improvement at 80% overall correct classification (1.25 * 63.3% = 79.9%) for the fitted model.

The first block of predictors consists of four continuous measures of risk perceptions (perceived susceptibility to H1N1, perceived severity of H1N1, perceived efficacy of the H1N1 vaccine, and perceived risks of the H1N1 vaccine) which were added simultaneously to the logistic model in a single step. The model containing the four risk perception measures (see Table 3) demonstrated adequate fit to the data according to the nonsignificant results of the *HL deciles of risk test* χ^2 (8) = 11.803, p = .160. Significant results for the model χ^2 (4) = 77.217, $p < .001$ indicate that the set of predictors are significantly associated with H1N1 vaccine acceptance. The pseudo R^2 indices (R^2_{CS} = .387, R^2_{NAG} = .529) indicate that the predictors account for approximately between 39% and 53% of the variance in the model. Correct classification improved substantially to 81.6% overall correct classification; 89% for vaccine rejecters and 69% for vaccine accepters. Therefore, the model containing the four risk perceptions alone surpasses the 79.9% cutoff criterion established for effective model improvement in classification accuracy.

In order to assess whether the addition of past seasonal flu shot uptake improved the model's capacity to classify accepters of the H1N1 vaccine, the dichotomous variable indicating typical past vaccination for the seasonal flu shot was added on the second step of the logistic regression analysis. Addition of this variable resulted in a statistically significant overall model, χ^2 (5) = 114.682, $p < .001$ with statistically significant improvement over the model containing risk perceptions alone, χ^2 (1) = 15.836, $p < .001$. The model fit the data well according to the *HL deciles of risk* χ^2 (8) = 4.606, p = .799, ns, with pseudo R^2 measures (R^2_{CS} = .445; R^2_{NAG} = .608) indicating between 45% and 61% of variance in vaccine acceptance group membership is explained by the set of predictors.

Parameter estimates and odds ratios of the main effects logistic model predicting H1N1 vaccine acceptance from the four risk perceptions and past seasonal flu shot uptake are presented in Table 4. Classification accuracy on the basis of these five predictors was 83.5% correct overall, with 88% of the H1N1 vaccine rejecters and 75.9% of the vaccine accepters bring correctly classified (see Table 5). According to the Wald statistic, only three of the four risk perceptions were statistically significant at the .05 probability level. Because of a weakness in the Wald χ^2 statistic that makes it prone to type II errors in models with large effects or in small samples, a validation of the significance of individual predictors is warranted. Likelihood ratio tests of nested models excluding each of the individual predictors are presented in Table 6 for demonstrating the propensity for type II error through the Wald chi-square statistic for the perceived vaccine efficacy predictor. The likelihood ratio test comparing the full model to a nested model that excludes perceived vaccine efficacy results in a statistically significant change in deviance (-2LL) of 4.082 (p = .042), implying that the predictor is significantly associated with vaccine acceptance group membership.

Table 3. Associations of Risk Perceptions (mean-centered) with H1N1 Vaccine Acceptance.

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for Exp(B)	
								Lower	Upper
Step 1[a]	Perceived Likelihood of H1N1	.92	.23	15.87	1	<.001	2.51	1.60	3.95
	Perceived Severity of H1N1	.15	.06	6.38	1	.012	1.16	1.03	1.30
	Perceived Risks of the H1N1 Vaccine	-.22	.06	11.47	1	.001	.80	.71	.91
	Perceived Efficacy of the H1N1 Vaccine	.74	.32	5.22	1	.022	2.09	1.11	3.93
	Constant	-.97	.24	16.11	1	<.001	.38		

a. Likelihood H1N1 refers to perceived likelihood of infection under the condition that one is not vaccinated; Severity H1N1 refers to the consequences of H1N1 infection, if experienced; H1N1 Vaccine Risks refers to the possible health risks of receiving the H1N1 vaccine; H1N1 Vaccine Efficacy refers to the single item measure of agreement with a statement about the H1N1 vaccine's efficacy in protecting oneself from infection. All risk perception measures have been mean-centered. N = 158.

Table 4. Initial Logistic Regression Model on H1N1 Vaccine Acceptance

	B	S.E. (B)	Wald's χ^2	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Perceived Likelihood of H1N1	.99	.27	13.92	1	<.001	2.69	1.60	4.51
Perceived Severity of H1N1	.17	.07	6.23	1	.012	1.18	1.04	1.35
Perceived Efficacy of the H1N1 Vaccine	.72	.37	3.77	1	.052	2.05	.99	.95
Perceived Risks of the H1N1 Vaccine	-.19	.07	7.40	1	.007	.83	.72	.95
Past Flu Shot	1.87	.49	14.36	1	<.001	6.48	2.46	17.02
Constant	-7.36	2.28	10.35	1	.001	.001		

Test	χ^2	df	*p*	
Overall Model Evaluation				
Likelihood Ratio Test	93.05	5	*p*<.001	
Goodness-of-Fit Test				
Hosmer & Lemeshow	4.61	8	.80	
Pseudo R^2 indices				
Cox and Snell				.45
Nagelkerke				.61

Table 5. Classification Table for Initial Logistic Regression Model on H1N1 Vaccine Acceptance

	Observed		Predicted: H1N1 Vaccine Acceptance: Reject H1N1	Accept H1N1	Percentage Correct
Step 1	H1N1 Vaccine Acceptance	Reject H1N1	88	12	88.0
		Accept H1N1	14	44	75.9
	Overall Percentage				83.5

a. The cut value is .500

Table 6. Likelihood Ratio Tests of Nested Model if Term Removed

Variable		Model Log Likelihood	Change in -2 Log Likelihood	df	Sig. of the Change
Step 1	Perceived Likelihood of H1N1	-66.03	17.38	1	<.001
	Perceived Severity of H1N1	-60.93	7.17	1	.007
	Perceived Risks of the H1N1 Vaccine	-61.29	7.89	1	.005
	Perceived Efficacy of the H1N1 Vaccine	-59.38	4.08	1	.043
	Past Flu Shot	-65.26	15.84	1	.000

Factors Associated with Seasonal Flu Shot Acceptance

The second research question of objective 2 also asks if risk perceptions and past flu shot uptake are associated with acceptance of the current seasonal flu shot. An identical sequential logistic regression was run to assess correlates of vaccine acceptance for the seasonal flu shot. Identical measures for continuous risk perception predictors are entered in the same order as the prior logistic regression on H1N1 vaccine acceptance, with the only differences being the substitution of risk perception measures for seasonal influenza and the dependent variable representing group membership for seasonal flu shot acceptance.

Among the 158 respondents, 70 were classified as seasonal flu shot accepters, 88 were flu shot rejecters. Correct classification based on membership in the proportionally largest outcome group in the null model was 55.7 %, with a 25% improvement in classification accuracy indicated by a final overall classification rate of 69% (55.7% * 1.25 = 69.26%). The null model deviance (-2LL) was 216.979.

The first block of the logistic regression model predicting acceptance of the seasonal flu shot included the four continuous measures of perceived risks associated with seasonal influenza (perceived likelihood of infection without the seasonal flu shot and perceived severity of the consequences of catching the seasonal flu), and the seasonal flu shot (perceived risks associated with the seasonal flu shot and agreement with a statement of the protective efficacy of the seasonal flu shot). The overall model containing the four risk perceptions pertaining to the seasonal flu and the flu shot provided adequate model fit to the data according to model χ^2 (4) = 71.022, $p < .001$). Nonsignificant results for the *HL deciles of risk* χ^2 (8) = 9.220, p = .324, indicates that the fitted model does not deviate significantly from observed frequencies. Pseudo R^2 indices ($R^2_{CS} = .362$, $R^2_{NAG} = .485$) indicate that the predictors are able to account for approximately 36% to 48% of the variance in the model. Classification on the basis of these seven predictors was 78.5% correct overall, with 84.1% of the flu shot rejecters and 71.4% of the vaccine accepters correctly classified. As shown in Table 7 all four of the risk perception predictors were significantly associated with flu shot acceptance group membership in the theoretically proposed directions.

The overall fit of the model including the dichotomous predictor of habitual flu shot uptake in addition to the four continuous measures of risk perceptions provided marginal overall fit to the data according to the nonsignificant *H-L deciles of risk test*, χ^2 (8) = 15.351, $p = .053$. A substantial decrease in the *H-L* χ^2 statistic is suggestive of a possible misspecification in the model that will be addressed in the interaction assessments. Adding the dichotomous dummy-coded variable indicating habitual seasonal flu shot uptake substantially improved the model over prior steps (χ^2_{block} (1) =

20.081, $p < .001$), with pseudo R^2 indices of ($R^2_{CS} = .438$, $R^2_{NAG} = .587$) indicating that the model now accounts for between 43.8% and 58.7% of the variance in the outcome. Overall classification was 84.2%, with 87.5% of the vaccine rejecters and 80% of flu shot accepters correctly classified by the full model. Parameter estimates for the model containing all five predictors are presented in Table 8, with the classification table for this model in table 9. The odds of flu shot acceptance increased by a factor of over 8.5 for persons who indicate that they typically get the seasonal flu shot compared to persons who do not typically get the seasonal flu shot OR = 8.640, (95% CI of 3.138 to 23.787). Three of the risk perceptions continued to be significantly associated with vaccine acceptance group membership in the directions hypothesized by the HBM. That is, acceptance for the seasonal flu shot is positively related with increased scores on perceived severity and perceived likelihood of the seasonal flu, and negatively associated with perceived risks of the seasonal flu vaccine. After entering the habitual flu shot predictor into the third step of the logistic model, agreement with perceived efficacy of the vaccine was associated with increasing odds of vaccine acceptance; however, the relationship was no longer a significant predictor OR = 1.412, 95% CI (.734 to 2.714).

Table 7. Association of Risk Perceptions to Acceptance of Seasonal Flu Shot

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Step 1[a]	Perceived Likelihood of Seasonal Flu	.78	.20	15.58	1	< .001	2.19	1.48	3.22
	Perceived Severity of Seasonal Flu	.13	.06	4.70	1	.030	1.14	1.01	1.28
	Perceived Risks of the Seasonal Flu Shot	-.19	.06	8.85	1	.003	.83	.73	.94
	Perceived Efficacy of the Seasonal Flu Shot	.65	.31	4.37	1	.037	1.91	1.04	3.51
	Constant	-.38	.21	3.37	1	.067	.68		

a. All variables are entered simultaneously on the first step of the logistic regression analysis. N = 158

Table 8. Association of Risk Perceptions (mean-centered) and Past Flu Shot (dichotomous) on Acceptance of Seasonal Flu Shot

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Step 2[a]	Perceived Likelihood of Seasonal Flu	.72	.22	10.79	1	.001	2.05	1.34	3.14
	Perceived Severity of Seasonal Flu	.18	.07	6.43	1	.011	1.19	1.04	1.36
	Perceived Risks of the Seasonal Flu Shot	-.16	.07	5.60	1	.018	.85	.74	.97
	Perceived Efficacy of the Seasonal Flu Shot	.35	.33	1.07	1	.30	1.41	.73	2.71
	Past Flu Shot	2.16	.52	17.42	1	<.001	8.64	3.14	23.79
	Constant	-1.06	.28	14.87	1	<.001	.35		

a. Variable(s) entered on step 2: Past Flu Shot. N = 158

Table 9. Association of Risk Perceptions (mean-centered) and Past Flu Shot (dichotomous) on Acceptance of Seasonal Flu Shot

			Predicted		
			Flu Shot Acceptance		Percentage
	Observed		Reject Flu Shot	Accept Flu Shot	Correct
Step 1	Flu Shot Acceptance	Reject Flu Shot	74	14	84.1
		Accept Flu Shot	12	58	82.9
	Overall Percentage				83.5

a. The cut value is .500

Exploratory Analysis of Interactions and Effect Modification

Due to the minimum required ratio of 10 cases of the smallest proportional outcome group per predictor included in the multiple logistic regression model, further analyses on the outcome of H1N1 vaccine acceptance group membership are deemed exploratory given the increased chance of overfitting of the model with only 58 members of the H1N1 vaccine acceptance outcome group and five main effects already included in the model. Because the number of cases in the smallest proportional outcome group for the logistic regression model predicting acceptance of the seasonal flu shot has a greater number of respondents in the seasonal flu shot acceptance outcome group (n = 70), the maximum number of predictors that may be included in the model predicting acceptance of the seasonal flu shot is seven. Through the following exploratory interaction assessments may capitalize on chance associations (in particular for the model on H1N1 vaccine acceptance) and observed significant interaction effects will be used in the final logistic regression model. All further results should be interpreted in light of this limitation.

Interactions Between Pairs of Risk Perceptions for H1N1 Vaccine Acceptance

Prior to testing for possible interactions between hypothesized interactions between pairs of risk perceptions, each of the continuous measures of risk perceptions was transformed into standardized z-scores before forming the product terms representing the interactions between continuous risk perceptions. Results of adding the pair of interactions between standardized (z-score transformed) risk perceptions are presented in Table 10. Results indicate that the addition of these two interaction terms did not improve upon the model containing the main effects for the four risk perceptions and habitual flu shot uptake, block χ^2 (2) = .344, p =.334, ns. The lack of significant improvement in the model implies that the association of these two interactions with H1N1 vaccine acceptance does not significantly differ from zero. Therefore, the results were unable to reject the null hypotheses stating that there are no conditionally dependent effects on vaccine acceptance for the interaction between perceived likelihood and perceived severity, as well as for the interaction between perceived vaccine efficacy and perceived vaccine risks. Given that there is no evidence in the present data which would support a rejection of the null, both interaction terms are therefore excluded from the final model for the sake of parsimony.

Table 10. Interactions Between Pairs of Risk Perceptions (z-scored)

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Perceived Likelihood H1N1	1.02	.27	14.22	1	<.001	2.76	1.63	4.67
	Perceived Severity H1N1	.16	.07	5.95	1	.015	1.18	1.03	1.34
	Perceived Risks of the H1N1 Vaccine	-.19	.07	7.50	1	.006	.83	.72	.95
	Perceived Efficacy of the H1N1 Vaccine	.86	.41	4.49	1	.034	2.36	1.07	5.22
	Last Flu shot (1)	1.88	.50	14.35	1	<.001	6.57	2.48	17.40
	Perceived Likelihood H1N1 (z-score) by Perceived Severity H1N1 (z-score)	.38	.27	1.10	1	.158	1.46	.86	2.46
	Perceived H1N1 Vaccine Efficacy (z-score) by Perceived H1N1 Vaccine Risks (z-score)	.27	.36	.57	1	.452	1.31	.6	2.62
	Constant	-1.73	.36	23.51	1	<.001	.178		

Interactions Between Pairs of Risk Perceptions for Seasonal Flu Shot Acceptance

Two interactions between standardized (z-score) risk perception predictors were entered into the logistic regression model. As shown in Table 11, adding the two interaction terms did not improve upon the model containing only the main effects of the predictors, block χ^2 (2) = .720, p = .698, ns. Since neither of the two interactions between standardized risk perceptions significantly contributed to the overall model, the null hypothesis was retained for both interaction terms having no effect in the prediction of seasonal flu shot acceptance, and the two interaction terms were dropped for sake of parsimony.

Table 11. Parameter Estimates for Regression Model Testing a Pair of Interactions Between Risk Perceptions (standardized z-scores)

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Perceived Likelihood of Seasonal Flu	.70	.22	9.96	1	.002	2.01	1.30	3.11
	Perceived Severity of the Seasonal Flu	.17	.07	6.23	1	.013	1.19	1.04	1.36
	Perceived Risks of the Seasonal Flu Shot	-.16	.07	5.53	1	.019	.85	.74	.97
	Perceived Efficacy of the Seasonal Flu Shot	.37	.34	1.19	1	.275	1.45	.74	2.83
	Past Flu Shot(1)	2.15	.51	17.69	1	<.001	8.59	3.15	23.39
	Perceived Likelihood of the Seasonal Flu (z-score) by Perceived Severity of the Seasonal Flu (z-score)	.20	.28	.49	1	.486	1.22	.70	2.13
	Perceived Flu Shot Efficacy (z-score) by Perceived Risks of the Seasonal Flu Shot (z-score)	.19	.32	.34	1	.558	1.21	.64	2.26
	Constant	-1.027	.281	13.329	1	.000	.358		

Exploratory Analysis of Effect Modification by Past Flu Shot Uptake on Risk Perception-Vaccine Acceptance Relationships

In order to answer the research question asking whether the associations between risk perceptions differed significantly between respondents who report that they typically receive the seasonal flu shot from those who report that they do not receive the seasonal flu shot, separate runs of the multiple logistic regression analysis were conducted which include four interaction terms between past flu shot uptake and each of the four risk perceptions. As with the exploratory assessments of interactions between pairs of risk perceptions presented in the previous section, the same limitations concerning the interpretation of significant results in light of small outcome group sizes are also relevant to the analysis of effect modification of the risk perception-vaccine acceptance relationship by past flu shot uptake.

Moderation of the Risk Perception-H1N1 Vaccine Acceptance Relationship by Self-Reported Past Flu Shot Uptake

Interactions were formed between the dichotomous dummy-coded indicator variable indicating past flu shot status (designated as the effect modifier) and each of the four mean-centered risk perception predictors to test whether the associations between each of the risk perceptions on vaccine acceptance are significantly different between the two levels of habitual flu shot uptake. Interactions between dichotomous and continuous predictors serve as tests of different effects of the continuous variable for each level of the dichotomous moderator (typically receives the flu shot annually, coded 1, otherwise 0). Because the designated moderator is a dichotomous indicator-coded dummy-variable signifying group membership it is not necessary to standardize the variable, however, the use of transformed mean-centered continuous variables is used to avoid multicollinearity between interaction terms and their constituent main effects.

Adding the set of four interaction terms to the model did not significantly improve overall model fit according to the block χ^2 (4) = 7.141, p = .129, ns. Therefore, the null hypotheses were retained, as there were no significant differences between levels of past flu shot uptake group for each of the four risk perceptions in predicting H1N1 vaccine acceptance. Parameter estimates of the model including the four interaction terms between mean-centered risk perceptions by groups formed by habitual flu shot status are presented in Table 12.

Table 12. Assessment of Moderation of Risk Perceptions by Past Flu Shot

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Step 1	Perceived Likelihood H1N1	1.39	.41	11.20	1	.001	4.00	1.78	9.00
	Perceived Severity H1N1	.28	.10	8.02	1	.005	1.32	1.09	1.59
	Perceived Risks of the H1N1 Vaccine	-.19	.09	4.09	1	.043	.83	.69	.99
	Perceived Efficacy of the H1N1 Vaccine	.98	.51	3.30	1	.069	2.66	.93	7.67
	Past Flu Shot	2.31	.61	14.47	1	<.001	10.10	3.07	33.27
	Past Flu Shot by Perceived Likelihood H1N1	-.58	.60	.93	1	.335	.56	.18	1.81
	Past Flu Shot by Perceived Severity H1N1	-.29	.17	3.08	1	.079	.75	.54	1.04
	Past Flu Shot by Perceived H1N1 Vaccine Risks	.01	.14	.01	1	.925	1.01	.76	1.35
	Past Flu Shot by Perceived Efficacy of the H1N1 Vaccine	-.42	.81	.27	1	.602	.66	.13	3.22
	Constant	-2.13	.48	19.72	1	<.001	.12		

Moderation of Risk Perceptions for Seasonal Flu by Level of Past Flu Shot

Interactions were formed between the dichotomous dummy-coded predictor indicating habitual flu shot status and each of the four mean-centered risk perception predictors to test whether the associations between each of the risk perceptions significantly differ according to identification with reporting that one typically gets the seasonal flu shot.

Parameter estimates of the set of interaction terms between habitual flu shot and the four mean-centered interaction terms are presented in Table 13. Adding the four interaction terms to the model improved the overall model fit from the main effects model, block χ^2 (4) = 16.588, *p* = .002, suggesting that at least one of the coefficients of the interaction terms differed significantly from zero. A significant interaction was observed between flu shot habit and perceived likelihood of infection, indicating that the effect of perceived likelihood of infection is conditionally dependent on the respondent's status on habitual flu shot uptake.

In order to provide more precise estimates of the fitted parameters of the model, nonsignificant interactions were removed and the analysis was re-run excluding the three nonsignificant interaction terms. A likelihood ratio test between the full model containing the main effects of all predictors and all four interactions with the nested model containing the main effects of the predictors and the single significant interaction were not significant; block χ^2 (3) = 2.990, *p* = .393 ns, suggesting that the set of interaction terms do not contribute to the model and may be dropped for sake of parsimony. Parameter estimates for the reduced model are presented as the final fitted model of seasonal flu shot acceptance in Table 14.

Table 13. Interactions Between Past Flu Shot (dichotomous) and Risk Perceptions (mean-centered)

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1	Perceived Likelihood of the Seasonal Flu	1.43	.37	15.20	1	<.001	4.18	2.04	8.59
	Perceived Severity of the Seasonal Flu	.26	.10	7.29	1	.007	1.30	1.08	1.57
	Perceived Risks of the Seasonal Flu Shot	-.23	.09	7.18	1	.007	.79	.67	.94
	Perceived Efficacy of the Seasonal Flu Shot	.04	.42	.01	1	.931	1.04	.46	2.36
	Past Flu Shot	2.65	.64	17.37	1	<.001	14.11	4.07	49.00
	Past Flu Shot by Perceived Likelihood of the Seasonal Flu	-1.88	.57	10.86	1	.001	.15	.05	.47
	Past Flu Shot by Perceived Severity of the Seasonal Flu	-.09	.17	.28	1	.595	.91	.65	1.28
	Past Flu Shot by Perceived Risks of the Seasonal Flu Shot	.17	.16	1.08	1	.300	1.19	.86	1.64
	Past Flu Shot by Perceived Efficacy of the Seasonal Flu Shot	1.34	.85	2.50	1	.114	3.81	.73	19.98
	Constant	-1.32	.35	14.27	1	<.001	.27		

Table 14. Reduced Final Model Containing the Interaction Between Perceived Likelihood (mean-centered) and Past Flu Shot (dichotomous) on Acceptance of the Seasonal Flu Shot

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1	Perceived Likelihood of the Seasonal Flu	1.40	.36	15.17	1	.000	4.04	2.00	8.17
	Perceived Severity of the Seasonal Flu	.23	.08	8.34	1	.004	1.26	1.08	1.47
	Perceived Risks of the Seasonal Flu Shot	-.19	.07	6.82	1	.009	.83	.72	.95
	Perceived Efficacy of the Seasonal Flu Shot	.39	.36	1.13	1	.289	1.47	.72	3.01
	Past Flu Shot	2.75	.60	20.90	1	.000	15.69	4.82	51.08
	Past Flu Shot by Perceived Likelihood of the Seasonal Flu	-1.87	.54	11.75	1	.001	.16	.05	.45
	Constant	-1.27	.33	14.463	1	.000	.282		

The results of the final fitted logistic regression model of seasonal flu shot acceptance from risk perceptions, past flu shot uptake, and the interaction between perceived likelihood and past flu shot are presented in Table 14. Odds of vaccine acceptance increase with increasing scores on perceived severity and decrease with increases in perceived vaccine risks. Increasing level of agreement with perceived vaccine efficacy is associated with concomitant increases in the odds of vaccine acceptance; however, this last relationship is not statistically significant. A significant interaction between flu shot habit and perceived likelihood of infection was observed, Wald χ^2 (1) = 11.748, p =.001, OR of 6.454 with 95% CI (2.222 to 18.746), indicating that the effect of perceived likelihood of infection is conditionally dependent on the respondent's past flu shot uptake. The interpretation of this interaction and its constituent effects follows from Jaccard (2001).The logistic coefficient associated with perceived likelihood of contracting the seasonal flu is no longer representative of a main effect, but rather is representative of the conditional effect of likelihood when the values on the moderator variable are zero (i.e. for respondents who report not typically receiving the seasonal flu shot). Therefore, 4.044 is the multiplicative factor by which the odds of vaccine acceptance change for a 1-unit increase in perceived likelihood among persons who do not typically receive the seasonal flu shot. The confidence intervals around the odds ratio provide an estimate of the sampling error and precision of this estimate. Because the confidence intervals do not contain the value of 1.0, it is statistically significant.

The interaction term represents the ratio of the multiplicative factor by which the predicted odds of accepting the seasonal flu shot change given a 1-unit increase in perceived likelihood for respondents who typically vaccinate for the seasonal flu, divided by the corresponding multiplicative factor by which the odds change for a 1-unit increase in perceived likelihood for respondents who do not typically vaccinate for the seasonal flu. In other words, as perceived likelihood increases, the ratio of odds ratios becomes smaller (i.e. there is less difference in the relative probability of vaccine acceptance over rejection) between those who typically get the flu shot and those who do not typically get the flu shot. Specifically, for each 1-unit increase in perceived likelihood of becoming infected with seasonal influenza the odds ratio representing the differences in odds of vaccine acceptance between past habitual flu shot receivers compared to those who are not, becomes smaller by a factor of Exp(-1.865) = .155, with a corresponding 95% CI

(.053 to .450). To illustrate this interaction between perceived likelihood of infection for the seasonal flu by level of habitual flu shot, the predicted probabilities obtained from the logistic regression equation for the model containing the main effects and the interaction term are plotted according to values of perceived likelihood of the seasonal flu for groups according to status of habitual flu shot in Figure 7.

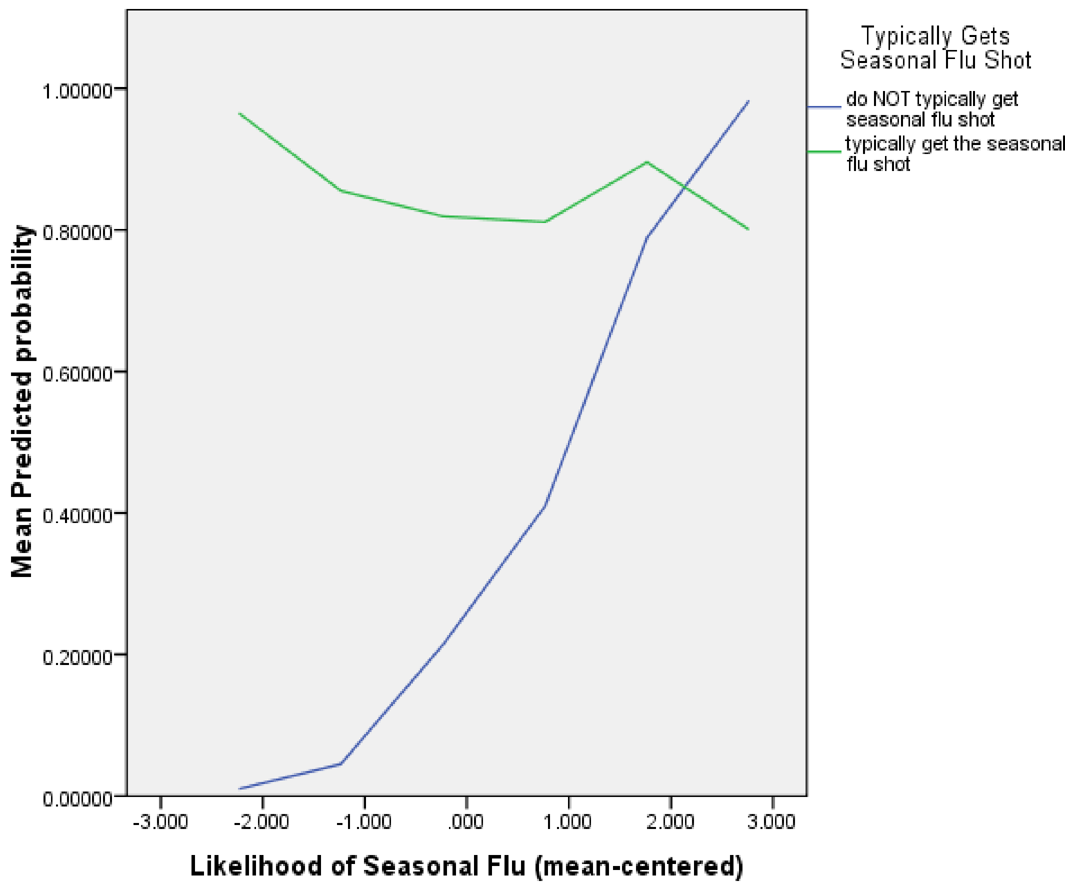

Figure 1. Plot of interaction between habitual flu shot status and perceived likelihood of infection for the seasonal flu by predicted probability of the final fitted model.

Summary and Final Logistic Regression Models

Separate logistic regression analyses were performed to predict vaccine acceptance group membership for seasonal and outbreak H1N1 influenzas from four continuous measures of risk perceptions and a dichotomous measure of self-reported typical seasonal flu shot uptake in the past. Exploratory analyses include the interaction between perceived severity and perceived susceptibility, as well as between perceived vaccine risks (barriers) and perceived vaccine efficacy (benefit), and the moderation of the risk-perception-vaccine acceptance relationship by level of past flu shot uptake. Models were fit using data collected over two weeks during the initial release of the H1N1 vaccine through the university's Student Health Center. Data were collected from 158 respondents to an online survey assessing attitudes and beliefs regarding seasonal and H1N1 influenza and their respective vaccines. Missing values on 44 numerical items were imputed using the mean value for the item for the respondent's respective outcome group. Preliminary analysis revealed a violation of the assumption of linearity in the logit for one of the continuous predictors (perceived vaccine efficacy), which was subsequently replaced with a single item measure of agreement with the efficacy of the vaccine in order to achieve linearity. There were no indications that multicollinearity or multivariate outliers were an issue during preliminary runs of the model through OLS regressions. Diagnostic plots of predicted probabilities against diagnostic criteria revealed two cases in the H1N1 model and three cases in the seasonal flu model which were subsequently removed due to poor model fit and undue influence on parameter estimates. Excluding these cases had a net effect of increasing parameter estimates, fit statistics, and classification rates for both models. The final sample sizes maintained the minimum ratio of 10:1 cases of the event per predictor variable included in the model. There was no indication that any of the continuous predictors violated the assumption of linearity in the logit after replacing the measure of perceived vaccine efficacy (difference score) with an alternative measure of agreement with a statement about the vaccines' efficacy in protecting oneself from infection. The research questions and pertinent results are presented in the following paragraphs.

The first research question (objective 1) asked whether perceptions of risk pertaining to the seasonal flu and the flu shot were significantly different from those pertaining to outbreak H1N1 influenza and the newly developed H1N1 vaccine. Within-subjects analysis using direct difference *t*-tests was performed comparing mean levels of risk perceptions between the flu types among the 158 respondents (see Table 2). Significant differences between measures of risk perceptions were found for perceived likelihood of infection, perceived severity of infection, and perceived health risks of the vaccine. Though not significant at the Bonferroni-corrected alpha level of $p < .0125$, agreement with a statement of vaccine efficacy was significantly associated with vaccine acceptance group membership at the conventional (.05) level of probability for rejecting the null hypothesis.

The second research question (objective 2) asked whether the core risk perception constructs of the HBM are associated with acceptance of the H1N1 vaccine and the seasonal flu shot, separately, among members of the present university-derived sample. The research hypotheses state that vaccine acceptance group membership is associated with each of the four risk perceptions: perceived severity, perceived susceptibility, vaccine efficacy, and vaccine risks. Controlling for the influence of other risk perceptions, vaccine acceptance for both seasonal and outbreak H1N1 influenza was found to be significantly associated with increased scores of perceived likelihood of infection, increased perceived severity of infection, and increased agreement with vaccine efficacy, as well as decreased scores on perceived risks of the vaccines (see table 7 for results pertaining to acceptance of the seasonal flu shot and table 3 for results pertaining to H1N1 vaccine acceptance). These results are consistent with previous findings and are in the predicted direction proposed by the HBM.

In addition to the four risk perceptions posited by the HBM, objective 2 also addresses whether past seasonal flu shot uptake is also associated with present flu shot acceptance as well as acceptance of the H1N1 vaccine. In order to test whether self-reported typical seasonal flu shot uptake is also associated with acceptance of the H1N1 vaccine and the present year's seasonal flu shot, both logistic regression models were run with past flu shot in addition to the four risk perceptions. The research hypothesis posits that habitual flu shot status is able to significantly improve the model's ability to classify respondents beyond the influence of risk perceptions alone. Results obtained from both models were able to reject the null hypotheses stating that the addition of self-reported typical past seasonal flu shot uptake would not improve the model's ability to discriminate between groups. Both models were able to reject the null hypotheses for most predictors in theoretically proposed directions once solution outliers (two from the model predicting H1N1 vaccine acceptance, and three from the model predicting seasonal flu shot acceptance) were removed from the analysis (see tables 15 and 17 for final models excluding outliers). Removing outlying cases in order to improve the model fit suggests that unmeasured confounding factors likely played a role in modeling these cases. Past seasonal flu shot uptake demonstrated significant associations with acceptance of the H1N1 vaccine and the seasonal flu shot. This finding supports the contention that similar social cognition factors are associated with the seasonal flu as with vaccines for the vaccine developed in response to the H1N1 outbreak. Once past flu shot uptake is taken into account, however, previously significant associations between agreement with vaccine efficacy and vaccine acceptance group membership were no longer significant for the model predicting acceptance of the seasonal flu shot (Table 8), but remained significant for the model predicting acceptance of the H1N1 vaccine (Table 4). This finding suggests that past flu shot uptake may be confounded with or may be part of a mediational relationship with perceived vaccine efficacy and seasonal flu shot acceptance; however, this study was unable to formally test this possibility without additional tests and proper assessment through longitudinal analysis that is required to provide appropriate evidence for such a conclusion.

The third research question (objective 3) asked whether vaccine acceptance is better modeled from the interactions between perceived severity and perceived susceptibility of infection, as well as the interaction between perceived risks of the vaccines and perceived efficacy of the vaccines. Interaction terms were constructed between standardized (z-scored transformed) continuous measures of perceived severity and perceived susceptibility which were then entered into the logistic regression model in a third block. Results were not able to reject the null hypotheses that these interactions were better able to predict the associations between risk perceptions and vaccine acceptance for the H1N1 vaccine (Table 10) or the seasonal flu shot (Table 11).

Therefore there is no evidence to suggest that perceived likelihood and perceived severity or perceived vaccine efficacy and perceived vaccine risks interact, or are otherwise dependent on levels of one another in predicting vaccine acceptance for either the seasonal flu shot or the H1N1 vaccine.

The fourth research question (objective 4) asked whether the associations between risk perceptions and vaccine acceptance are moderated by whether or not a person reports that they typically receive the seasonal flu shot in past years. This set of hypotheses regard the differential influence of risk perceptions on vaccine acceptance group membership between respondents who typically seek the seasonal flu shot in the past versus those who report that they have not typically sought the seasonal flu shot. Specifically, the null hypothesis for both seasonal and outbreak influenza models states that there will be no significant difference between habitual past flu shot users and those who are not, across any of the given risk perceptions. Such an effect would be indicated by a significant interaction term between the dichotomous past flu shot predictor and a given risk perception. Results indicated that only one of the risk perceptions (perceived likelihood) was found to have a significantly interactive association with vaccine acceptance for the seasonal flu shot (table 13 and table 14). However, this interaction was not observed for acceptance of the H1N1 vaccine (table 12). It is possible that other interactions might have been observed in either of the models, however, small sample sizes and restrictions on the number of predictors that could be reasonably included without overfitting likely precluded establishing such associations.

Final models are presented for reduced samples which exclude outliers who were not fit by the data and exerted excessive influence on parameter estimates of the logistic regression models on vaccine acceptance for the H1N1 vaccine and the seasonal flu shot. Appendix B demonstrates the procedures for identification of individual cases. The logistic regression model on H1N1 vaccine acceptance was run without two outlying cases to determine the extent to which their presence affected the results of the model. Regression coefficients and model goodness of fit statistics for the main effects model on H1N1 vaccine acceptance group membership containing all 5 predictors is presented in table 15, with classification tables presented for this model in table 16. Identical procedures were able to identify three outlying cases in the seasonal flu shot logistic regression model that included all five main effects and the interaction term. Parameter estimates for the final logistic regression model predicting acceptance of the seasonal flu shot are presented in table 17, and its associated classification table presented in table 18. The results of removing outliers from both models improved overall model fit statistics and classification accuracy and did not change the significance or direction of any of the parameter estimates included in either model.

Table 15. Final Logistic Regression Model on H1N1 Vaccine Acceptance, Excluding Outliers

	B	S.E. (B)	Wald's χ^2	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Likelihood H1N1	1.31	.32	16.87	1	<.001	3.72	1.99	6.96
Severity H1N1	.25	.08	9.71	1	.002	1.28	1.10	1.49
H1N1 Vaccine Efficacy	1.02	.43	5.69	1	.017	2.77	1.20	6.38
H1N1 Vaccine Risks	-.21	.08	7.56	1	.006	.81	.70	.94
Past Flu Shot	2.14	.60	14.64	1	<.001	8.48	2.84	25.37
Constant	-7.36	2.28	10.35	1	.001	.001		

Test	χ^2	df	p	
Overall Model Evaluation				
Likelihood Ratio Test	106.89	5	*p*<.001	
Goodness-of-Fit Test				
Hosmer & Lemeshow	3.36	8	.91	
Pseudo R^2 indices				
Cox and Snell				.50
Nagelkerke				.68

Table 16. Classification Table[a] for Final Logistic Regression Model Predicting H1N1 Vaccine Acceptance

	Observed		Predicted: H1N1 Vaccine Acceptance: Reject H1N1	Accept H1N1	Percentage Correct
Step 1	H1N1 Vaccine Acceptance	Reject H1N1	89	10	89.9
		Accept H1N1	13	44	77.2
	Overall Percentage				85.3

a. The cut value is .500

Table 17. Final Logistic Regression Model on Seasonal Flu Shot Acceptance, Excluding Outliers.

	B	S.E. (B)	Wald's χ^2	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Perceived Likelihood of Seasonal Flu	2.12	.54	15.59	1	<.001	8.33	2.91	23.87
Perceived Severity of Seasonal Flu	.30	.10	10.03	1	.002	1.35	1.12	1.63
Perceived Efficacy of the Seasonal Flu Shot	.63	.41	2.30	1	.129	1.87	.83	4.21
Perceived Risks of the Seasonal Flu Shot	-.21	.08	6.31	1	.012	.81	.69	.96
Past Flu Shot	3.26	.70	21.52	1	<.001	26.07	6.57	103.37
Past Flu Shot by Perceived Likelihood of the Seasonal Flu	-2.70	.71	14.51	1	<.001	.07	.02	.27
Constant	12.97	3.29	15.64	1	<.001	.00		

Test	χ^2	df	p	
Overall Model Evaluation				
Likelihood Ratio Test	118.35	6	<.001	
Goodness-of-Fit Test				
Hosmer & Lemeshow	3.41	8	.91	
Pseudo R^2 indices				
Cox and Snell				.53
Nagelkerke				.72

Table 18. Classification Table[a] for Final Logistic Regression Model on Seasonal Flu Shot Acceptance, Excluding Outliers

	Observed		Predicted: Flu Shot Acceptance: Reject Flu Shot	Accept Flu Shot	Percentage Correct
Step 1	Flu Shot Acceptance	Reject Flu Shot	74	13	85.1
		Accept Flu Shot	8	60	88.2
	Overall Percentage				86.5

a. The cut value is .500

V: DISCUSSION

Public acceptance of new vaccines is a crucial factor in controlling disease. To increase vaccination rates of existing vaccines and facilitate acceptance of new vaccines, such as the 2009 H1N1 influenza vaccine, it is important to understand the motivators for and barriers to vaccination among persons who are not typically regarded as at-risk for infection-related morbidity and mortality. University settings have been identified as centers for disease transmission as well as venues for disease control and prevention through vaccine outreach efforts targeting students ("Use of Influenza A (H1N1) 2009 Monovalent Vaccine," 2009). However, little is known about college students' attitudes towards influenza and immunization, especially with regard to outbreak pandemics, such as the 2009 H1N1. The lack of research is concerning given the demonstrated impact of the seasonal flu and other influenza-like-illnesses among university students and the potential impact of pandemic influenzas from which the vast majority of this cohort is not expected to have any pre-existing immunological resistance.

The Health Belief Model for preventive health behaviors describes acceptance and uptake of preventive health behaviors, such as vaccination, from individual's subjective perceptions concerning a given health hazard and the specific recommended protective actions under consideration. In terms of acceptance of vaccines for seasonal and outbreak influenzas, these core constructs have been defined in this thesis as the following; 1) perceived likelihood of infection given that one is not vaccinated for the specific influenza, 2) the perceived severity, or seriousness of the consequences of experiencing an infection, 3) perceived health risks believed to be associated with the seasonal flu shot or the newly developed H1N1 vaccine, and 4) the perceived efficacy of the vaccines to reduce ones likelihood of becoming infected. It is thought that the perceived severity and perceived likelihood of influenza combine to a latent dimension of perceived threat, and that the barriers dimension of perceived risks of the vaccines is overcome by perceived benefits provided by the vaccines. In addition to these core constructs and interactions among them, this thesis also takes into account one's perceptions concerning regular past vaccination for the seasonal flu, both as an independent predictor as well as a possible moderator of the associations between other risk perceptions and vaccine acceptance.

Review of Methodology

The research questions addressed in this thesis research are addressed in four sections. The first research question (objective 1) asks whether risk perceptions differ between seasonal and 2009 H1N1 outbreak influenzas. Four within-groups direct-difference t-tests were performed to test whether levels of the four risk perceptions significantly differed from zero. The second research question (objective 2) concerns what factors are associated with acceptance of vaccines for seasonal and outbreak influenzas. In order to address this second research question, separate multiple logistic regression analyses were developed to assess vaccine acceptance for the seasonal flu shot and the H1N1 vaccine from risk perceptions and past habitual flu shot uptake among a sample of 158 university members who responded to an online survey. The influence of the four risk perceptions on vaccine acceptance were assessed simultaneously on the first step of the logistic regression model. The influence of the binary predictor variable measuring the perception that one typically vaccinates for the flu shot was assessed in a second step of the analysis, controlling for the effects of the four risk perceptions. The third research question (objective 3) addressed a pair of hypothesized interactions between pairs of risk perceptions. To address this, exploratory runs of the regression models were performed to test for hypothesized interactions through hierarchical backwards elimination of interaction terms to form reduced models containing only main effects and significant interaction terms. The fourth research question (objective 4) asks whether the risk perception-vaccine acceptance relationship differs between persons who regularly receive the seasonal flu shot as compared to those who do not. Moderation interactions were tested in exploratory additional runs of the logistic regression model. Final logistic regression models were constrained by the allowable number of predictors to maintain the minimal 10:1 cases to predictor ratio for both regression models predicting vaccine acceptance for H1N1 and seasonal flu shot separately.

Summary of Results

In terms of the first research question (objective 1) comparing relative levels of perceived risks between seasonal and outbreak influenzas, results of the within-groups t-tests identified three of the four risk perceptions that significantly differed between seasonal and outbreak H1N1 influenzas. Specifically, the H1N1 influenza was perceived to be more severe than the seasonal flu; however, the sample also reported a lesser likelihood of becoming infected with the H1N1 influenza. Concerning perceptions relative to the vaccines, there were no significant differences in perceptions of the two vaccine's efficacy levels; however, there was a greater level of perceived risks associated with the newly developed H1N1 vaccine. Given that the analysis did not control for vaccine acceptance or past vaccination, these results reflect sample-wide comparisons of risk perceptions.

The second research question (objective 2) asks which of the risk perceptions are related to acceptance of vaccines for the seasonal and outbreak influenzas. The results of the present study provide confirmatory support for the relationships outlined by the HBM stating that vaccine acceptance for both seasonal and outbreak influenzas are positively associated with risk perceptions concerning the perceived likelihood and perceived severity of both influenza viruses. Acceptance of either the seasonal flu shot or the H1N1 vaccine are positively related to increased perceived likelihood of infection if one does not receive the vaccine (perceived susceptibility) as well as increased seriousness of the consequences of infection (perceived severity). Past flu shot uptake regularity was also found to have a strong independent association with acceptance of both vaccines, as well as serving to moderate the relationship between perceived likelihood of infection and acceptance of the seasonal flu shot in exploratory logistic regression models (discussed below). Concerning the HBM-defined perceptions related to perceptions of vaccines, perceived vaccine risks was found to be negatively associated with acceptance of either vaccines, whereas perceptions of vaccine efficacy were found to be associated with acceptance of the H1N1 vaccine, but not for the seasonal flu shot once past flu shot uptake and its moderation interaction with perceived likelihood were taken into account in the final exploratory regression model.

Results provide support for the research hypothesis stating that habitual uptake of the seasonal flu shot is associated with vaccine acceptance for both seasonal and outbreak influenzas. Knowledge of past flu shot uptake status improves prediction of vaccine acceptance beyond the influence of risk perceptions alone. After entering the past flu shot predictor into the model predicting H1N1 vaccine acceptance, perceived vaccine efficacy continues to be associated with H1N1 vaccine acceptance group membership once outliers have been removed. However, the effects of perceived efficacy of the seasonal flu shot are no longer significantly associated with acceptance of the seasonal flu shot once habitual flu shot uptake is accounted for in the analysis. These findings suggest that habitual flu shot accounts for the association between perceived vaccine efficacy and acceptance of the seasonal flu shot but not for the H1N1 vaccine. Past flu shot uptake behavior seems to be an enabling factor for acceptance of new vaccines, but the evaluation of the efficacy of the new vaccines remains important in modeling vaccine acceptance associations.

The third and fourth research questions (objectives 3 and 4) are concerned with exploratory interaction effects. There was no evidence for interactions between the risk perceptions of perceived severity and perceived likelihood, nor between the perceived efficacy and perceived vaccine risks. There was partial support for the research question asking whether the relationship between each of the risk perceptions and vaccine acceptance is moderated by whether or not individuals typically receive the seasonal flu shot. Only the interaction between habitual flu shot uptake and perceived likelihood of infection from the seasonal flu was found to be significantly predictive of acceptance of the seasonal flu shot. However, none of the hypothesized interactions between risk perceptions and habitual flu shot uptake were found to be significant for the model predicting H1N1 vaccine acceptance. These findings suggest that increased perceptions of perceived likelihood of infection are associated with acceptance of the seasonal flu shot for persons who do not typically vaccinate for the seasonal flu. However, for persons who typically receive or attempt to receive the seasonal flu shot on an annual basis, the perceived likelihood of infection seems to be elevated but invariant in terms of its relationship to vaccine acceptance, and thus there is no increase in odds of vaccine acceptance for habitual flu shot users across levels of perceived likelihood. Therefore, assessment of the perceived likelihood of infection may be important for acceptance of new health behaviors. None of the hypothesized interactions between risk perceptions and habitual flu shot uptake were found to be significant for the model predicting H1N1 vaccine acceptance. One possible explanation is that the logistic regression analysis lacked sufficient power to detect statistically significant interactions in the H1N1 vaccine acceptance model. Increasing the size of the sample might have resulted in the detection of significant interaction effects for the H1N1 model. Although the regression analysis likely lacked power to detect interactions between continuous predictors if they actually exist in the population, both theoretical and phenomenological arguments against such complex cost-benefit evaluations may also serve to explain lack of significant interaction effects.

Strengths

To the best knowledge of the author, this study is the first to assess and compare factors associated with acceptance of vaccines for outbreak and seasonal influenza among members of a university sample. This study is also unique in that it assesses the possibility of interaction effects between risk perceptions and past flu shot uptake behavior for both seasonal and outbreak influenzas. This study was delimited by its specific setting and members, who are rarely approached to participate in outbreak illness research. This study also made best use of available methodological considerations for the development and implementation of the survey questionnaire items in attempting to control for future intentions and past experiences in developing the research instrument used to assess risk perceptions.

Limitations

The present research is subject to several limitations. First, the results of the present study are correlational and must be interpreted in light of the typical limitations of cross-sectional designs. The effects of predictors should not be interpreted as causal in nature, but may be more appropriately interpreted as characteristics associated with groups defined by their vaccine acceptance group. It is impossible to rule out the role of extraneous third variables that may account for the observed between-group differences. Additionally, the outcome group of vaccine accepters combines individuals who are already vaccinated with vaccine intenders who differ significantly in terms of perceived vaccine risks for both seasonal and H1N1 influenza vaccine acceptance groups.

Second, methodological considerations regarding the process used in the recruitment of participants for this study, as well as the format of the questionnaire itself, may create artificial differences between vaccine accepters and rejecters. The sampling procedure used to recruit participants resulted in a nonrepresentative sample of participants that does not reflect the population of the university where the study took place. Oversampling was apparent for both females and Caucasian demographic groups. The use of two methods for recruitment (in-class announcements in two undergraduate courses and one week of on-site solicitation at the university health center's vaccine outreach program) likely caused a biased response rate that elicited participation from individuals who are more interested in participating in research (for the vaccine outreach program recruitment site) or who are participating because of the extra-credit incentive provided by the two professors who opened their classrooms for recruitment. The use of non-probability-based sampling procedures to recruit potential research participants is a concern to the extent that the proportions of members in either of the outcome groups significantly differed from proportions of vaccine accepters and rejecters found in the population.

Third, transparency of the research motive was made explicit to the participants. Though the intent for designing a transparent questionnaire format was to engender honest and accurate responding, there exists the distinct possibility that social desirability bias could account for some of the differences observed between vaccine accepters and rejecters. Social desirability bias was not measured and may limit the validity of the study's findings to the extent that this response bias influenced responses by participants' exaggeration of both the desirability of their beliefs and behaviors, as well as the consistency between the two (Conner, 2007).

Fourth, time restrictions at the end of the academic year prevented recruitment of more participants through the classrooms of seven other course instructors as opportunities for in-class announcements became unavailable during the final weeks of the semester. Therefore, a limitation of this study is the small sample size used for the analysis. This study had an overall sample size of 158 respondents with useable data: 58 who were accepters of the H1N1 vaccine and 70 who were accepters of the seasonal flu shot. The maximum recommended number of independent variables allowed for logistic regression analysis is limited to the smaller of the two outcome groups divided by ten, leaving only five permissible independent predictors for the logistic regression on acceptance of the H1N1 vaccine, and seven for the logistic regression analysis on seasonal flu shot acceptance. Even when the minimum recommended ratio of cases to variables has been met, there is a tendency for logistic regression analyses to produce biased overestimates of individual odds ratios as well as solution outliers with extreme predicted values.

Fifth, the small functional sample size was a major limitation, resulting in a lack of theoretical saturation as variables were excluded from the analysis and less precise estimates of standard errors as indicated by the large confidence intervals around the point estimates calculated for the odds ratios. Including further variables in the analysis would run the risk of overfitting the model. This study was able to circumvent a violation of the assumption of linearity in the logit through replacement of the original measure of perceived vaccine efficacy (difference score) with an alternative item (Likert-type) intended for use in another measure that was excluded from the analysis. This substitution was possible only because several other measures were unable to be used in light of the study's final sample size. Several measures intended to lend a more theoretically saturated research endeavor were excluded in light of the small sample size, including the following: health orientation, cues to action, trait neuroticism, anxiety, characteristics relative to the CDC vaccine-recommended criteria, and alternative protective behavioral responses to influenza as well as perceptions of their efficacy in preventing infection from seasonal and outbreak influenza. Future research would be able to shed more light on the role played by such cognitive, emotional, and behavioral responses to outbreak diseases amongst similar populations.

Sixth, reliability estimates were available for only two of the four measures of risk perceptions. Reliability estimates for perceived likelihood of infection and perceived vaccine efficacy were originally intended to be measured by a single item due to the specific definition of the research constructs as risk perceptions. To obtain multiple-item reliability estimates for these variables would expand the operational definition of the constructs beyond that of personally-relevant risk perceptions. Variations on the construct of perceived likelihood of infection would encompass either comparative risk assessments of an individual makes about both themselves and of other individuals (Weinstein, 1984); or perceived vulnerability, defined as one's constitutional tendency towards illness in general (Brewer et al., 2007). Neither of these two constructs sufficiently operationalize the probabilistic component of experiencing a given health hazard without introducing the possibility of confounding probability-based estimates with referents towards external sources of comparison or internal sources related to one's health status.

Similarly, perceived vaccine efficacy, which was originally computed as a difference score between perceived likelihood of infection between the real or hypothetical conditions of being vaccinated or unvaccinated, would not be operationally defined as a risk perception per se if external benefits unrelated to the intended effect of reducing the likelihood of experiencing an illness (such as reducing absences) were measured. Though it should be noted that the original 4-item scale from which the substitute item measuring agreement with perceived vaccine efficacy was drawn from did exhibit acceptable estimates of internal-consistency reliability among the items (Cronbach's $\alpha = .91$ and .87 for items used for scales of the perceived benefits of H1N1 and seasonal flu vaccines, respectively, including the item used as a substitute for the original perceived vaccine efficacy difference score measure).

Seventh, there was no counterbalancing of order effects for measurement of the various risk perceptions. Thus, measures assessed earlier in the survey might have affected responses on later measures. However, the order of items was randomized within each of the sections measuring each of the research variables. Items that were considered sensitive or which may provoke reactivity were purposefully placed towards the end of the survey along with items that collected basic demographic information.

Eighth, the findings of the present study were not cross-validated on an independent or hold-out sample of respondents. The data were collected during a specific timeframe of the initial two weeks of the release of the H1N1 vaccine through the university health center from a sample of respondents that were primarily female, Caucasian, and younger than 25 years of age. It should be noted that the sample is not representative of the single central-Texas university where the study was conducted. In light of the specific context and sample in which this study was performed, the generalizability of the study's findings should be interpreted within similar timeframes, contexts, settings, and populations of the present research.

Implications and Future Research

For university students in the United States, a diverse cohort for whom precious little is known about the decision-making processes relative to preventive health behaviors, especially in the context of outbreak illnesses, the lack of familiarity and consistency of vaccination uptake may provide a venue for public health practitioners and providers to enhance vaccination through risk communication strategies which emphasize objective information concerning the efficacy of the seasonal flu shot. What is becoming more evident in research on vaccination attitudes and uptake is that the influence of past vaccination experiences has become one of the stronger predictors of uptake of vaccines. This research has demonstrated that past behavior also generalizes to similar vaccines, and that the main effects of using measures of risk perceptions and health beliefs may provide misleading results for measuring acceptance of the seasonal flu shot acceptance attitudes and uptake behaviors unless past behavior is taken into account. This study also demonstrates how such effects might mask the effects of risk perceptions unless between-groups comparisons are made. Future studies should begin to address the role of both past flu shot uptake behavior, not only in terms of one's perceptions that they typically receive or attempt to receive the seasonal flu shot, but also to begin using objective information and begin to address the context by which people perceive intermittently performed health behaviors. Additionally, it is important to start addressing the manner in which college students and other members of younger healthy cohorts perceive such behaviors in order to gain a better understanding of how educational campaigns and risk communication measures may reach such atypical at-risk populations in order to circumvent severe pandemic conditions. However, such research needs to begin to address more diverse student body populations, peer networks and social media in order to understand how these communication mediums serve to facilitate or inhibit acceptance of emergency responses for disease control and transmission. Additionally, more populations outside of university and workplace settings need to be addressed on the issue of perceived acceptability of vaccines and recommendations –not only from their own physicians, but from governmental officials and public health agencies as well.

In the traditional framework of the HBM, conscious decisions about health actions are made according to evaluations about a specified threat, subjectively perceived by the individual in terms of the likelihood and severity of experiencing the hazard, motivating the individual to then evaluate the benefits of and barriers towards the recommended health action (Janz & Becker, 1984). This complex process of making assessments of diverse risks and consequences and weighting them against each other assumes that the decision to vaccinate is a wholly rational endeavor that may be more accurate a description of such decisions made by professional actuaries or epidemiologists, rather than laypersons. The inherently rationalist perspective of the HBM limits the role of other emotionally-relevant components in the decision-making processes relevant to risks and health behaviors (Bish & Michie, 2010). It is possible that the decision to vaccinate may be more basic than the complex process of rationalist evaluation that is proposed by the HBM. For instance, Slovic et al. (2003) suggest that risk decisions stem more from how people feel about the behavior rather than what they think about the behavior. This risks-as-feelings hypothesis (Lowenstein, Weber, Hsee, &

Welch, 2001) suggests that emotional reactions to risks, rather than rational evaluations, serve to better explain the motivations leading to the performance of health behaviors. Other research has found that worrying about the consequences of experiencing influenza, as well as anticipated regret of becoming ill if one does not take preventive measures such as vaccination, are strong predictors of influenza vaccination (Chapman & Coups, 2001).

High correlations between predictors was expected and there were no indication that excessive multicollinearity was a problem in the present analysis, but discerning the role of the individual risk perceptions in relation to each other is beyond the scope of this research. It is possible in future research efforts to perform structural equation modeling or hierarchical logistic models on either dichotomous or polychotomous outcome groups if larger sample sizes are obtained.

Conclusion

When considering the results of the logistic regression models for both seasonal or outbreak influenzas, one cannot ignore the importance of habitual flu shot uptake, not only because of the strength of the association in predicting acceptance of either of the two vaccines, nor solely because of its influence as a variable that changes the strength and direction of the relationship between perceived efficacy beliefs and vaccine acceptance, but also its potential practical significance as a catalyst for understanding the role played by perceptions of vaccines for individuals who might not be familiar with the decision to vaccinate as a volitional, preventive health behavior.

The importance of this research is relevant in terms of the methodological considerations for future studies assessing risk perceptions and preventive health behaviors within university samples. More research is needed, however, to confirm findings associated with the interaction effects of past flu shot uptake on perceived likelihood of infection for the seasonal flu shot. Confirmatory research investigating this interaction might attempt to control for other extraneous factors, providing that the sample size is sufficiently large to permit for the estimation of effects in the presence of additional control variables.

APPENDIX A

Testing for Logistic Regression Assumptions

Assumption 1: Adequacy of Expected Frequencies of Categorical Variables

Preliminary contingency table analysis was performed to inspect the expected cell frequencies of the binary predictor indicating habitual flu shot uptake status against the binary outcomes for vaccine acceptance for seasonal and outbreak H1N1 influenza. The lowest obtained expected cell frequency (19.46) exceeded minimal χ^2 requirements recommended when employing categorical predictors in binary logistic regression (Tabachnick & Fidell, 2001).

Assumption 2: Multicollinearity and Multivariate Outliers

Preliminary assessment of excess multicollinearity is evaluated through employing tolerance statistics and variance inflation factors obtained from ordinary least squares regression (Menard, 2000). Preliminary multiple linear regression models on the binary outcome of vaccine acceptance were run using the same set of predictors as the logistic regression models. The largest obtained variance inflation factor was 1.806, while the smallest obtained tolerance was 0.554, indicating that multicollinearity is not an issue.

Multivariate outliers were assessed through inspection of Mahalanobis Distance values obtained from the preliminary multiple linear regression analysis. Multivariate outliers are indicated by χ^2 critical values at $p < .001$ with degrees of freedom equal to the number of predictors (5). A table of critical values was used to obtain the critical value of χ^2 (5) = 20.52, $p < .001$. The largest Mahalanobis Distance obtained from either of the two preliminary linear regression models was 17.478, suggesting that no multivariate outliers were not present in the sample data.

Assumption 3: Linearity in the Logit for Continuous Predictors

The Box-Tidwell approach is used to test for violations of the assumption that a linear relationship exists between continuous predictors and the logit transformation of the dependent variable. Table 2 illustrates how the Box-Tidwell approach was able to detect one such violation for the original measure for perceived vaccine efficacy (computed as a difference score between the pair of conditional perceived likelihood items). In order to compute the natural logarithm for difference scores less than or equal to zero, a constant value of 4.001 was added to the raw difference scores to linearly transform all values to be greater than zero. The natural logarithm was then calculated from the linearly transformed values and both were used to compute the interaction terms used in the Box-Tidwell tests.

After detecting the violation through the Box-Tidwell approach illustrated in Table 2, all further attempts to transform the difference score measure of perceived vaccine efficacy were not able to satisfy the assumption of linearity. It was decided that the measure would be replaced with an alternative item drawn from a related measure that was assessed among the participants but not used in the present analysis. The single-item measure assessed perceptions of vaccines personal protective value of the vaccines in preventing infection from seasonal or H1N1 influenza. The item utilized a 5-point

Likert-style response scale to measure respondent's level of agreement with the statement "*the (H1N1 vaccine/seasonal flu shot) is effective in protecting me from (Swine Flu/seasonal flu)."* The correlation coefficient between measures (r = .501) indicates the two measures were strongly associated. Replacing the original perceived vaccine efficacy difference score with the single-item Likert-style measure of agreement with the vaccines' protective efficacy was able to resolve the violation of the assumption of linearity in the logit (shown in Table 6).

Table A1. Box-Tidwell Approach Detecting a Violation of the Assumption of Linearity in the Logit for the Original Measure of Perceived Vaccine Efficacy (difference score)

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Perceived Vaccine Efficacy (difference score) plus 4.001	15.28	7.21	4.49	1	.03	4342865.40
	Perceived Likelihood of H1N1	-1.36	2.84	.23	1	.63	.26
	Perceived Severity of H1N1	-.19	1.32	.02	1	.89	.83
	Perceived Risks of the H1N1 vaccine	.81	1.22	.44	1	.51	2.26
	Past Flu Shot(1)	2.05	.54	14.70	1	<.001	7.78
	Ln_Perceived Likelihood H1N1 by Perceived Likelihood H1N1	1.17	1.37	.73	1	.39	3.22
	Ln_Perceived Severity of H1N1 by Perceived Severity H1N1	.09	.33	.08	1	.78	1.10
	Ln_Perceived H1N1 Vaccine Risks by Perceived H1N1 Vaccine Risks	-.30	.34	.78	1	.38	.74
	Ln_Perceived Vaccine Efficacy (difference score) plus 4.001 by Perceived Vaccine Efficacy (difference score) plus 4.001	-5.79	2.74	4.449	1	.035	.003
	Constant	-32.89	14.75	4.973	1	.026	.000

Assumption 4: Ratio of Cases to Variables

The total number of predictors in logistic regression analysis is limited by the number of cases in the smallest proportional outcome group. The minimum ratio of cases-to-variables recommended by Hosmer and Lemeshow (2001) is 10:1, where the number of cases is the smallest observed frequency of the two binary outcomes. A maximum of five predictors may be modeled for the logistic model of H1N1 vaccine acceptance group membership, whereas seven predictors are able to be included in the model predicting seasonal flu shot acceptance. Therefore, only main effects of the five predictors can be modeled for the logistic regression on H1N1 vaccine acceptance, whereas an additional pair of predictors may also be modeled for the analysis on seasonal flu shot acceptance. Assessments of interaction effects are exploratory due to the small sample and limited power. However, significant interaction effects are included as predictors in the logistic regression model predicting seasonal flu shot acceptance while maintaining the minimum case-to-predictor ratio of 10:1.

APPENDIX B

Model Diagnostics For Factors Associated with H1N1 Vaccine Acceptance

Table B1 presents results of the Box-Tidwell tests of the assumption of linearity in the logit for continuous predictors. The lack of significant results for the interaction terms between each continuous predictor and its natural logarithm provide evidence that there is no serious violation of the linearity in the logit assumption for any of the continuous variables in the model.

Plots of predicted probabilities against calculated values for delta chi-square ($dchi^2$), delta deviance (ddev), and delta standardized beta (dsbeta) are presented in Figures 1 through 3, respectively, along with the row number identifying outlying and influential cases marked for potential exclusion. Two cases are distinctly identifiable from a visual inspection of the regression diagnostic plots as solution outliers which were poorly fit by the model (Figure 2) and exert excessive influence on estimates of the model parameters (Figure 3 and 4).

Table B1. Box-Tidwell Tests of Linearity in the Logit for Continuous Predictors

Variable	B	S.E.	Wald	df	Sig.	Exp(B)
Perceived Likelihood of H1N1	-.82	2.78	.09	1	.77	.44
Perceived Severity of H1N1	.18	1.40	.02	1	.90	1.19
Perceived Risks of the H1N1 Vaccine	.51	1.26	.16	1	.69	1.67
Perceived Efficacy of H1N1 Vaccine	3.24	5.94	.30	1	.59	25.49
Ln_ Perceived Likelihood of H1N1 by Perceived Likelihood of H1N1	.86	1.33	.43	1	.51	2.37
Ln_ Perceived Severity of H1N1 by Perceived Severity of H1N1	-.001	.36	<.001	1	.98	.99
Ln_Perceived Risks of the H1N1 Vaccine by Perceived Risks of the H1N1 Vaccine	-.20	.36	.31	1	.58	.82
Ln_ Perceived Efficacy of H1N1 Vaccine by Perceived Efficacy of H1N1 Vaccine	-1.13	2.63	.19	1	.67	.32
Constant	-11.20	10.89	1.06	1	.30	.00

a. Variables preceded by “Ln_” refer to the natural logarithm transformation of the variable used in forming the multiplicative product term of a variable and its natural logarithm for assessment of linearity in the logit through the Box-Tidwell approach.

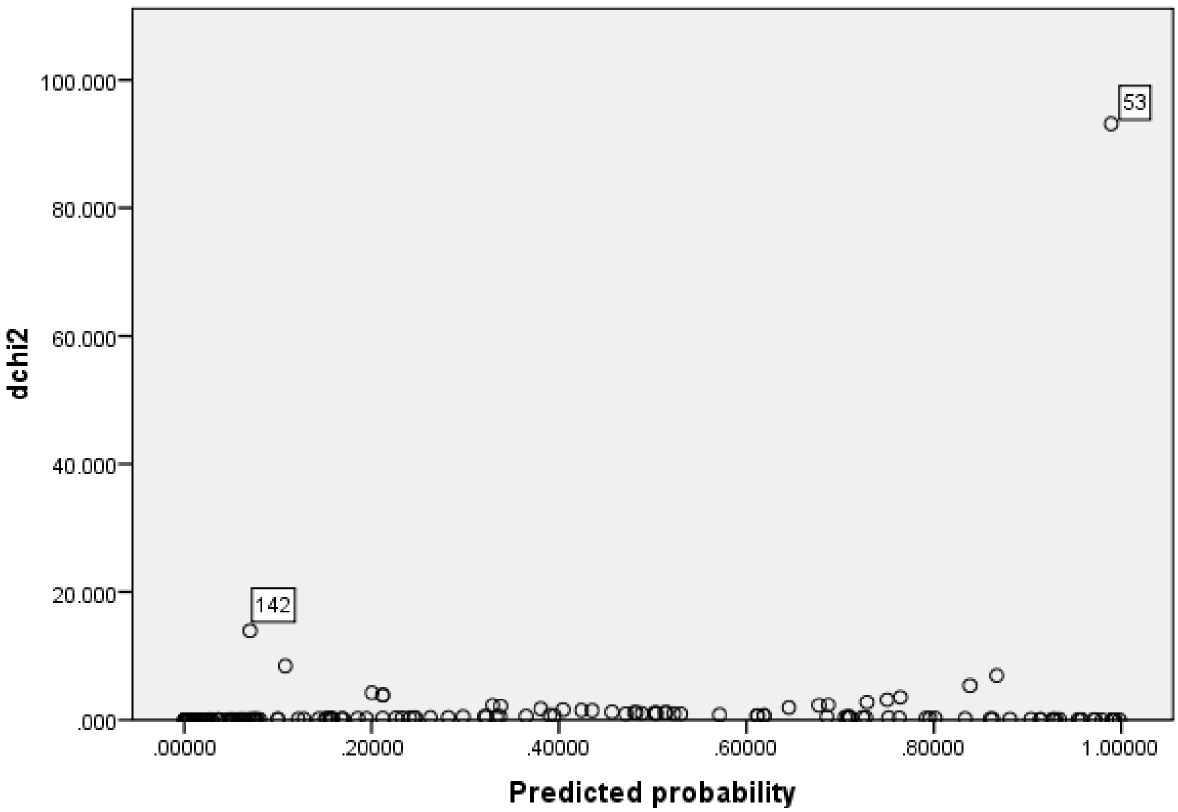

Figure 2. Casewise diagnostic plot of change in Pearson chi-square (dchi2) against the predicted probability of H1N1 vaccine acceptance group membership.

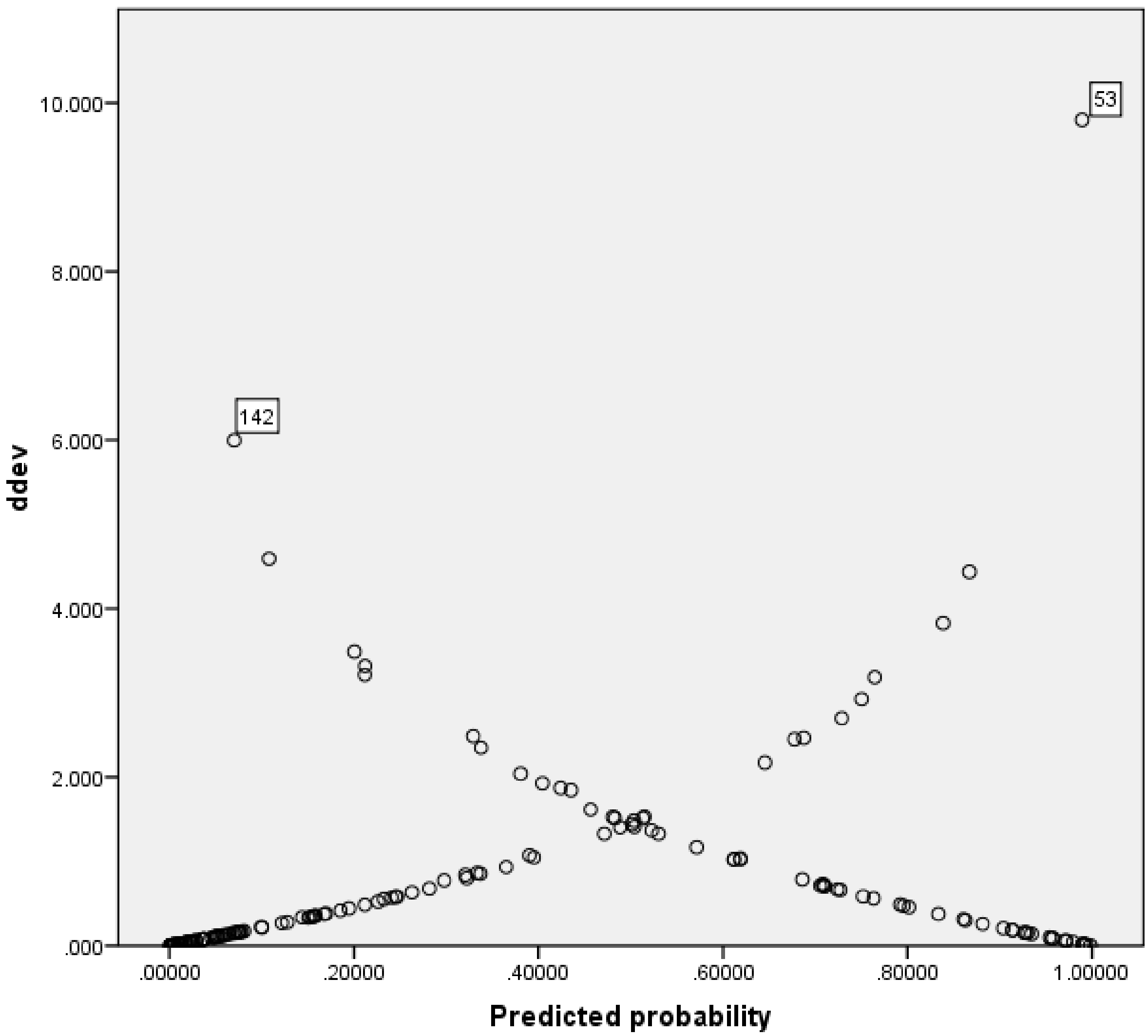

Figure 3. Plot of change in model deviance (ddev) against predicted probability of H1N1 vaccine acceptance group membership. Extreme cases enumerated.

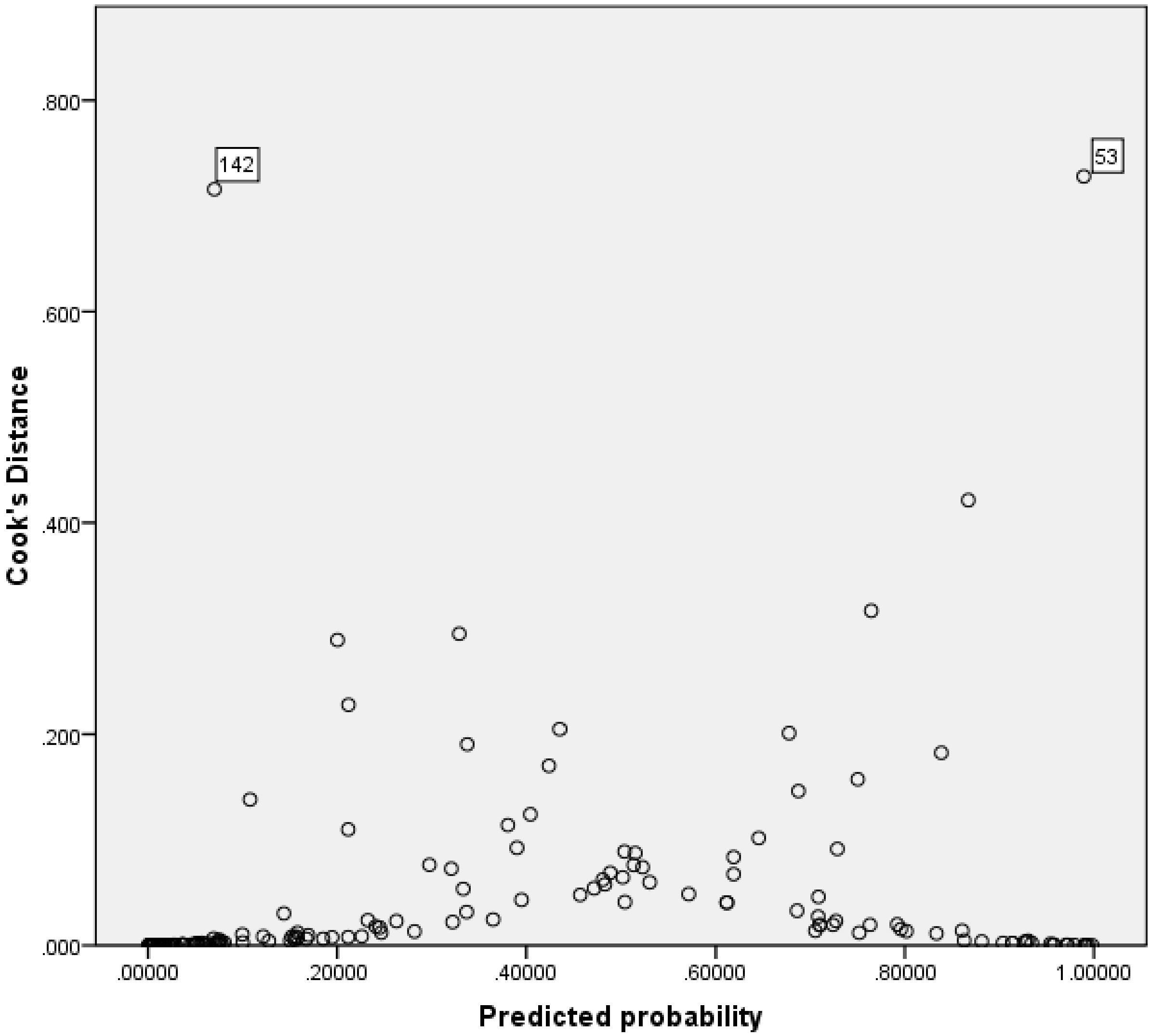

Figure 4. Plot of Cook's Distance analogue against predicted probability of H1N1 vaccine acceptance group membership. Extreme cases exerting excessive influence on model coefficients enumerated.

Model Diagnostics For Factors Associated with Seasonal Flu Shot Acceptance

The Box-Tidwell tests of the assumption of linearity in the logit for continuous predictors are presented in Table B2. The lack of significant interaction terms between each predictor and their natural logarithm indicate that there is no serious violation of the assumption of linearity in the logit among continuous predictors.

Table B2 Box-Tidwell Tests of Linearity in the Logit for Continuous Predictors

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Perceived Likelihood of Seasonal Flu	1.52	2.19	.48	1	.49	4.57
	Perceived Severity of Seasonal Flu	1.22	1.66	.54	1	.46	3.39
	Perceived Risks of the Seasonal Flu Shot	2.10	1.26	2.81	1	.09	8.20
	Perceived Efficacy of the Seasonal Flu Shot	.18	4.96	.001	1	.97	1.20
	Past Flu Shot(1)	2.12	.53	16.24	1	<.001	8.35
	Ln_Likelihood_Flu by Likelihood_Flu	-.37	1.03	.13	1	.72	.69
	Ln_Severity_Flu by Severity_Flu	-.28	.44	.40	1	.53	.76
	Ln_Risks Flu Shot by Risks Flu Shot	-.64	.36	3.26	1	.07	.53
	Ln_Efficacy Flu Shot by Efficacy Flu Shot	.08	2.24	.001	1	.97	1.09
	Constant	-18.34	10.53	3.04	1	.08	<.001

a. Variables preceded by "Ln_" denote the natural logarithm transformation of the variable used in the Box-Tidwell interaction terms.

Visual plots were constructed to identify residual, outlying and overly influential cases. Plots of predicted probabilities against delta chi-square ($dchi^2$), delta deviance (ddev), and delta standardized beta (dsbeta) are presented in Figures 4 through 6 respectively, along with the row number identifying outlying and influential cases marked for exclusion.

Inspection of these plots revealed four cases which were not fit well by the model. Three of the four cases were solution outliers with residual values beyond an absolute value of three standardized units. These three cases were removed from the analysis, which was re-run in order to assess the effects of removing these cases. The resulting model has substantially better fit to the data and these three outliers were excluded in the final analysis for the model predicting acceptance of the seasonal flu shot.

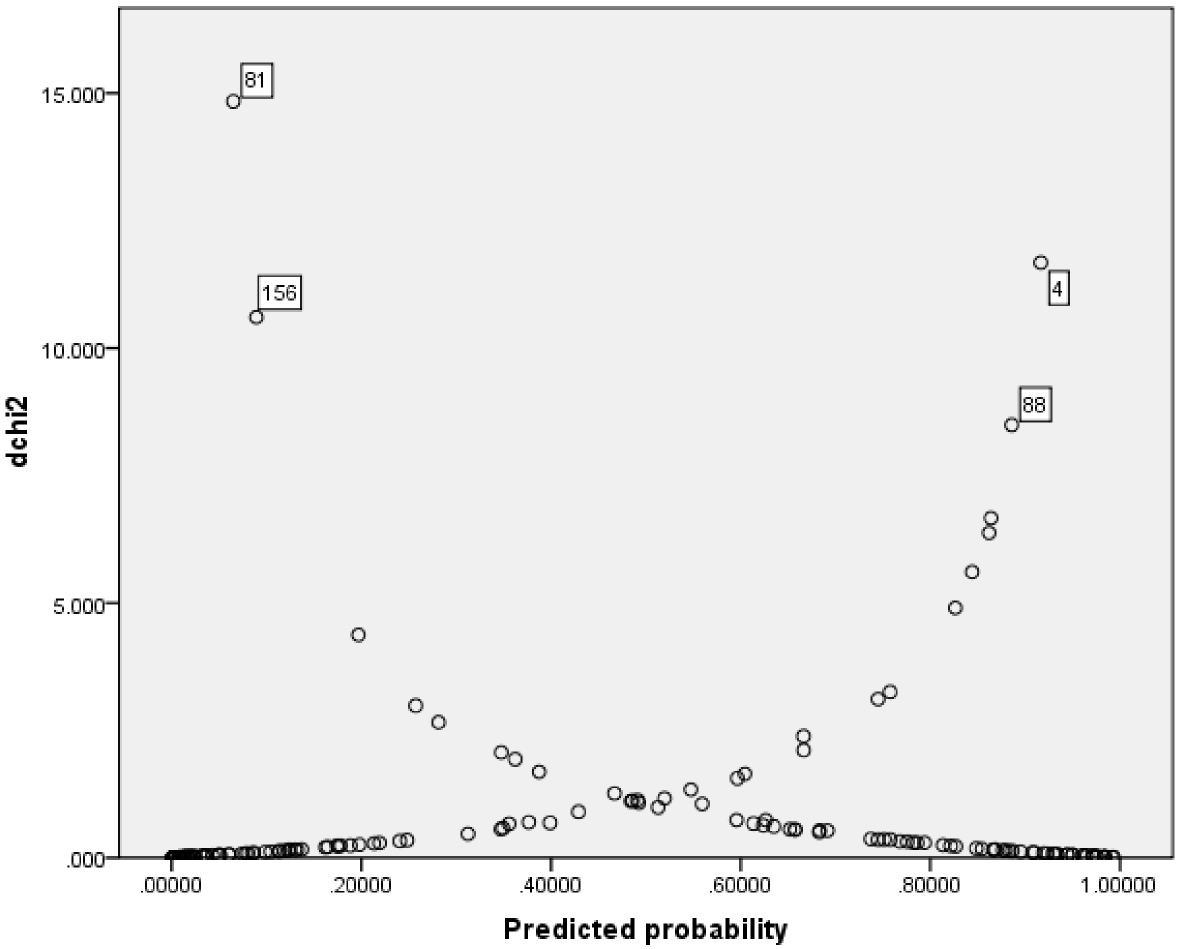

Figure 5. Casewise diagnostic plot of change in Pearson chi-square (dchi2) against the predicted probability of seasonal flu shot acceptance group membership. Extreme cases enumerated.

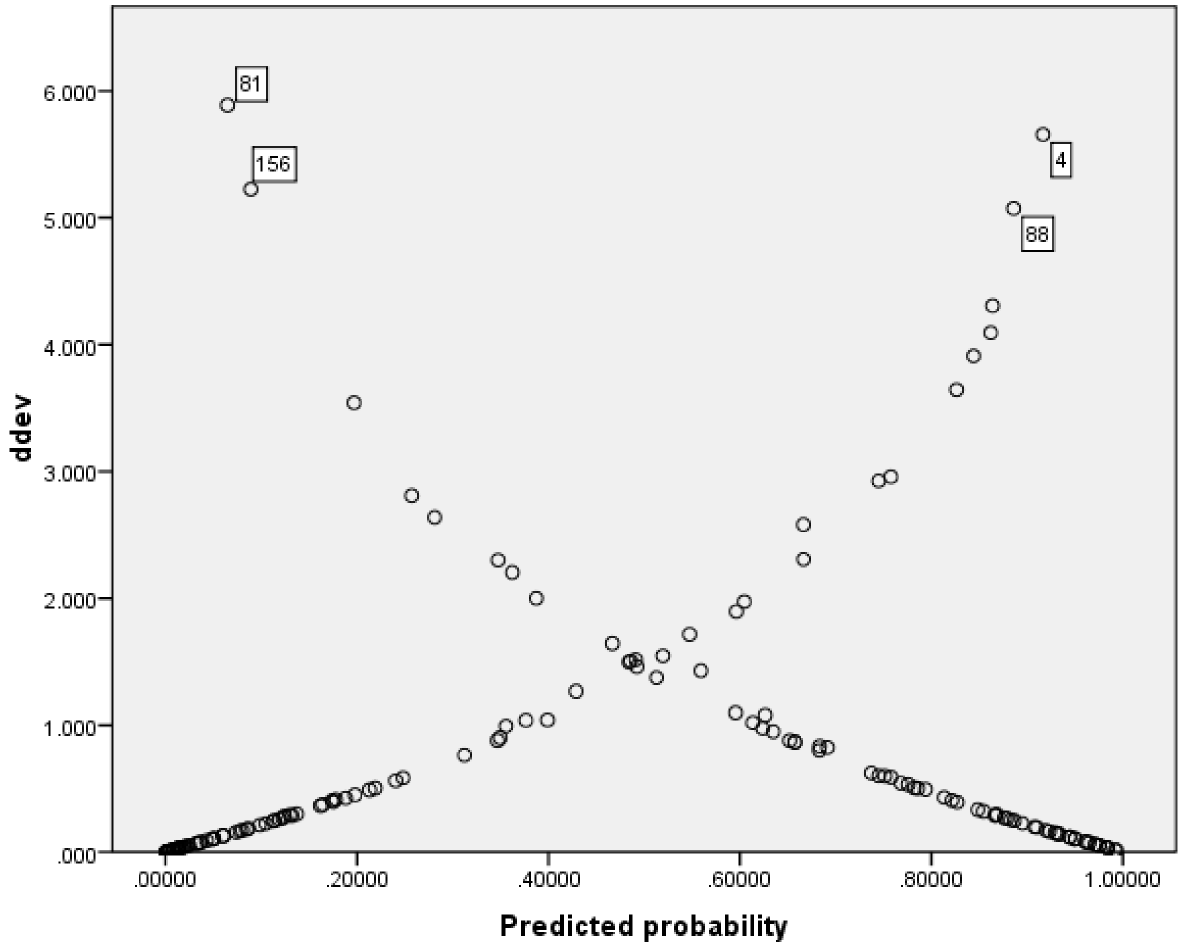

Figure 6. Plot of change in model deviance (ddev) against predicted probability of H1N1 vaccine acceptance group membership. Extreme cases enumerated.

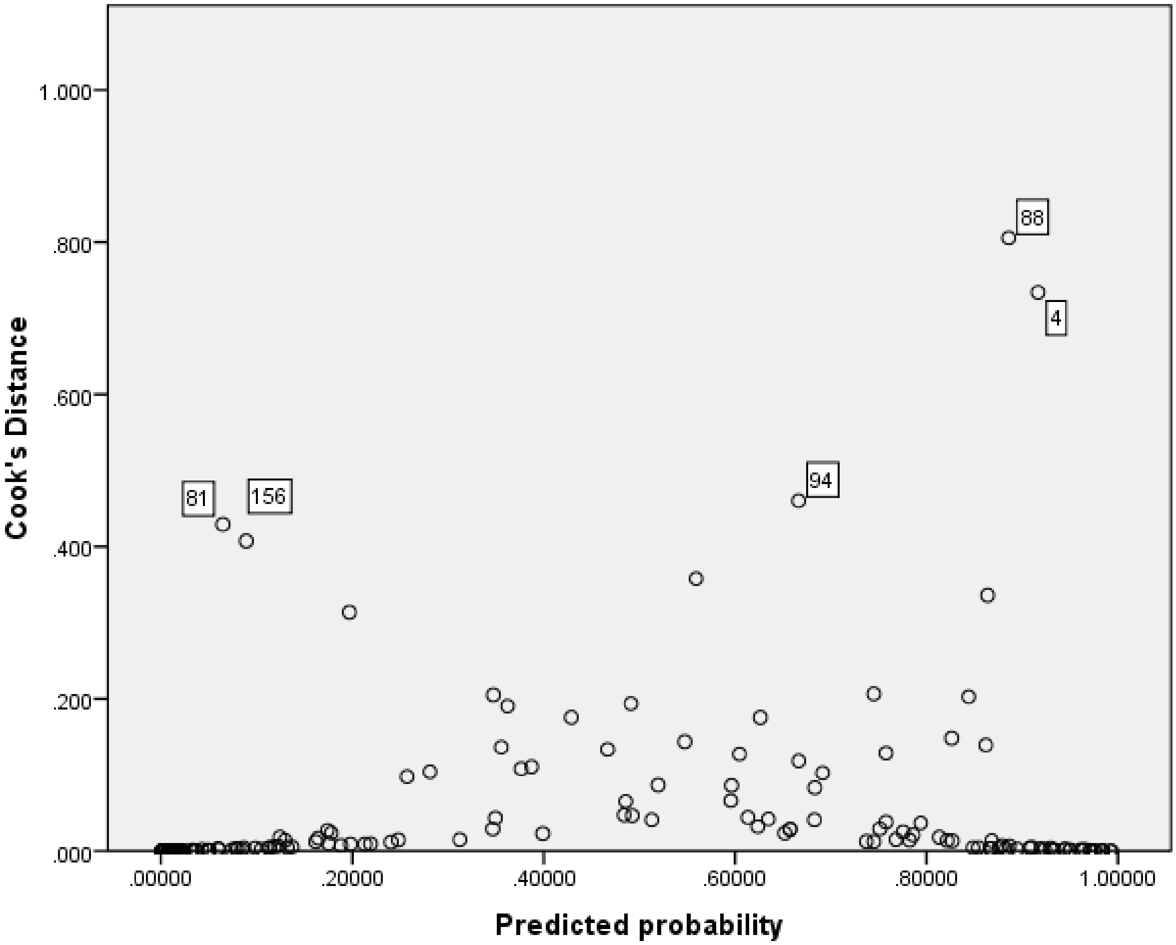

Figure 7. Plot of Cook's Distance analogue against predicted probability of seasonal flu shot acceptance group membership. Extreme cases exerting excessive influence on model coefficients enumerated.

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