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DISSERTATION

The Influence of Contact with Children, Contact with Healthcare Professionals, and Age on Influenza Vaccine Uptake

Amber Smith

RAND PARDEE RAND GRADUATE SCHOOL

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This document was submitted as a dissertation in August 2013 in partial fulfillment of the requirements of the doctoral degree in public policy analysis at the Pardee RAND Graduate School. The faculty committee that supervised and approved the dissertation consisted of Jeanne Ringel (Chair), Katherine Harris, and M. Rebecca Kilburn.

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Abstract

While the influenza vaccine is safe, efficacious, and recommended for everyone over the age of six months, rates of vaccination for seasonal influenza remain sub-optimal. During the 2011-2012 influenza season, only 39% of adults were vaccinated against influenza while the Healthy People 2020 goals aim to achieve vaccination rates of 80-90% (Centers for Disease Control and Prevention 2012; U.S. Department of Health and Human Services 2012). This dissertation consists of three papers which assessed factors associated with influenza vaccination among several populations, including healthcare professionals, adults who have close contact with children, and young and middle-aged adults, using data from focus groups, and the 2009 and 2010 RAND Influenza Vaccine Tracking Surveys. The main findings from the papers are 1) Healthcare professionals with children in the household were more likely to be vaccinated for H1N1 influenza but were no more likely to be vaccinated for seasonal influenza than healthcare professionals without children in the household, 2) Healthcare provider-issued reminders and recommendations for influenza vaccination were positively associated with influenza vaccine uptake among all adults regardless of age, and 3) Childcare workers were concerned that influenza vaccination would make them sick and were distrustful of physicians' advice to be vaccinated for influenza.

Contents

Figures

Tables

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1. Introduction

Influenza is a great public health concern. The Centers for Disease Control and Prevention (CDC) lists influenza and pneumonia as the eighth leading cause of death in the United States (Xu, Kochanek et al. 2010). Influenza also results in more hospitalizations and deaths among children in the United States than any other vaccine-preventable disease (Grijalva, Craig et al. 2006; Xu, Kochanek et al. 2010). Influenza can be prevented through vaccination. The influenza vaccine is safe, efficacious, and is recommended for everyone over the age of 6 months (Fiore, Uyeki et al. 2010). Despite this, rates of vaccination for seasonal influenza remain low.

Epidemiology of Influenza

Seasonal (Epidemic) Influenza

Influenza presents with a consistent set of symptoms but the influenza virus mutates rapidly and often mutation occurs on the glycoproteins which are targeted for immunity by vaccination (Potter 2001). One glycoprotein termed HA, which is targeted by vaccination, is tracked across influenza seasons to determine which influenza viruses will be present in the given season(Potter 2001). There are fifteen different HA molecules, each of which can have various subtypes depending on how much the molecule has mutated from its original state (Potter 2001). It is this mutation, termed antigenic drift, that results in seasonal influenza epidemics because immunity acquired against a given HA subtype is less effective against mutations of the HA molecule (Potter 2001).

Given this phenomenon, influenza epidemics occur annually in many countries, including the United States. Epidemics are most often seen during the winter months of a given region, likely because colder temperatures result in crowding of people (Potter 2001). Indeed in the United States this appears to be the case as influenza epidemics occur seasonally usually between late fall and early spring (Fiore, Uyeki et al. 2010). As such, influenza epidemics often begin in countries located in the Eastern or Southern hemispheres and then move to Europe and North America (Potter 2001).

Antigenic drift and the resulting influenza epidemics, necessitate vaccination against influenza annually prior to each influenza season (Potter 2001). Additionally, vaccination is required annually even in the absence of antigenic drift because the antibody we build up from vaccination against a given subtype declines over time (Potter 2001; Fiore, Uyeki et al. 2010).

H1N1 (Pandemic) Influenza

According to the World Health Organization (WHO) "[a]n influenza pandemic occurs when a new influenza virus emerges and spreads around the world, and most people do not have immunity (World Health Organization 2012)." A new influenza virus may emerge when antigenic shift occurs (Potter 2001). The relevance of antigenic shift relates to influenza immunity. When a virus strain appears that contains a subtype of HA that is unrelated to currently circulating influenza viruses, individuals do not have any immunity to this new virus strain (Potter 2001). As explained above, past infection with influenza or past influenza vaccination only confers immunity to the type of HA (or it's subtypes) contained by the infecting virus or targeted by the vaccine.

The H1N1 influenza virus was first identified in the United States in April 2009. Prior to this pandemic outbreak, this variant of the influenza virus had not been seen before in humans or animals (Centers for Disease Control and Prevention 2010). The virus spread throughout the world, with an estimated infection rate of 11 to 21 percent of the world's population (Kelly, Peck et al. 2011). The CDC estimated that 43 to 89 million cases of H1N1 influenza infection occurred in the United States resulting in 195,000 to 403,000 H1N1 influenza related hospitalizations and 8,870 to 18,300 H1N1 influenza related deaths between April 2009 and April 2010 (Centers for Disease Control and Prevention 2010).

Advisory Committee for Immunization Practices (ACIP) Recommendations and Healthy People 2020 Goals

Current Recommendations and Recent Changes

In order to protect against influenza, the CDC's Advisory Committee for Immunizations Practices (ACIP) currently recommends annual influenza vaccination for everyone over the age of six months (Fiore, Uyeki et al. 2010). The ACIP recommendations were expanded as of the 2010-2011 influenza season to include healthy adults aged 19 to 49. Prior to this, the recommendations did not include healthy, non-pregnant adults aged 19 to 49 (Fiore, Uyeki et al. 2010).

The ACIP recommendations also target certain groups as high priority for influenza vaccination. The ACIP recommends that when vaccine supply is limited, efforts to vaccinate should focus on specific subgroups including young children aged six months to four years, close personal contacts of children under age five and adults aged 50 and older, healthcare providers, and adults aged 50 and older (Fiore, Uyeki et al. 2010). These groups are targeted by the vaccine recommendations in order to protect individuals who are at high-risk for influenza-related complications.

Healthy People 2020 Goals

The CDC's ACIP isn't the only government organization that recognizes the importance of influenza vaccination among adults. Several of the Healthy People 2020 goals focus on influenza vaccination of adults (U.S. Department of Health and Human Services 2012). These goals aim to increase seasonal influenza vaccination to rates of 80 or 90 percent as outlined below.

- Increase the rate of seasonal influenza vaccination among healthcare professionals to 90 percent.
- Increase the rate of seasonal influenza vaccination among non-institutionalized adults aged 19 to 64 to 80 percent
- Increase the rate of seasonal influenza vaccination among high risk adults (e.g., adults who have close contact with young children) aged 19 to 64 to 90 percent.
- Increase the rate of seasonal influenza vaccination among non-institutionalized adults aged 65 and older to 90 percent

- Increase the rate of seasonal influenza vaccination among institutionalized adults aged 18 and older to 90 percent
- Increase the rate of seasonal influenza vaccination among pregnant women to 80 percent.

Rates of Influenza Vaccination

Despite the ACIP recommendations and Healthy People 2020 goals, vaccination rates remain low across the U.S. population. During the 2009-2010 influenza season, 44% of children age 6 months to 17 years, 28% of non-high risk adults aged 18-49, and 45% of adults aged 50-64 were immunized for seasonal influenza (Centers for Disease Control and Prevention 2010). Rates of vaccination for H1N1 were even lower during the 2009-2010 influenza season. Among all people aged 6 months and older, the vaccination rate was 27%, and among adults aged 25-64, the vaccination rate was 29% (Centers for Disease Control and Prevention 2011).

Overview of Current Study

In the current study, we propose a model of the influenza vaccine decision by drawing on several models of decision-making proposed in the literature (Fishbein and Ajzen 1975; Becker, Don et al. 1977; Montano 1986; Shahrabani, Gakni et al. 2008). We then go on to assess the influenza vaccine decision using data from nationally representative surveys of adults collected at the end of the 2008-2009 and 2009-2010 influenza seasons. We also analyze focus groups conducted with childcare workers at the beginning of the 2012-2013 influenza season. This dissertation includes three papers which assess the following:

- The association between children in the household and influenza vaccination among healthcare professionals and non-healthcare professionals.
- The association between healthcare provider-issued reminders and recommendations and influenza vaccination among adults aged 19 to 49 and adults aged 50 and older.
- The knowledge, attitudes, and beliefs about influenza vaccination among childcare workers.

We conclude with an assessment of the policy recommendations indicated by this research.

2. Vaccine Decision Model

Health Behavior Decision Models

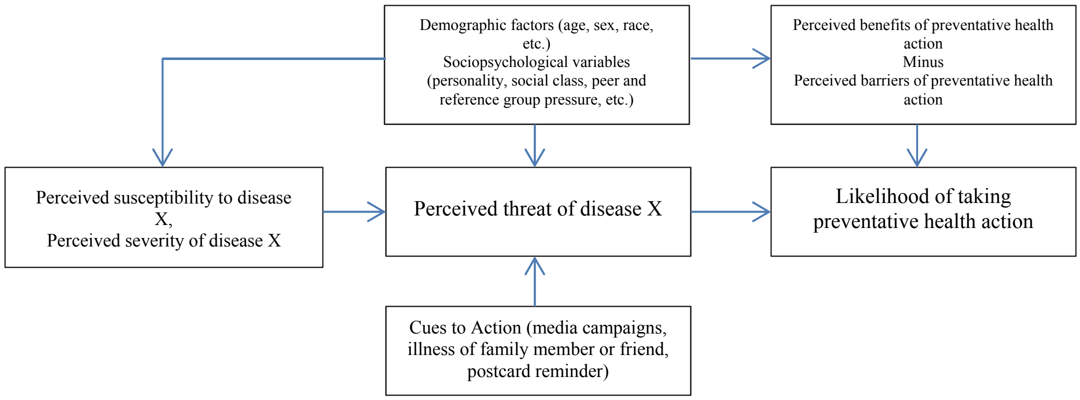
The decision to take up the influenza vaccine has been modeled in the economic literature and in the psychology literature. Both frameworks lend value in understanding the influenza vaccine decision. From the economic perspective, an individual will choose to be vaccinated if the expected utility from vaccination is higher than from non-vaccination. If we wish to affect the vaccine uptake decision we need to understand all of the components of the influenza vaccine decision expected utility function. This is where we can draw on the psychology literature. There are several models of health action decision-making proposed in the psychology literature, including the Health Belief Model (HBM; (Becker, Don et al. 1977; Janz and Becker 1984)), Fishbein's Behavioral Intention Model (Fishbein and Ajzen 1975), and Triandis' model of consumer decision making (Montano 1986). The HBM has been applied in several studies examining the influenza vaccine decision (van Essen, Kuyvenhoven et al. 1997; Nexøe, Kragstrup et al. 1999; Kwong, Pang et al. 2010). We briefly summarize each of the models and then incorporate ideas from them into the economic model presented below to yield a more complete model of the vaccine uptake decision.

Health Belief Model

The HBM, depicted in Figure 1, is used in several studies that aim to understand and predict influenza vaccination and other preventative health behaviors (van Essen, Kuyvenhoven et al. 1997; Nexøe, Kragstrup et al. 1999; Kwong, Pang et al. 2010). There are three key components to the HBM that interact to determine whether an individual takes up a given health action. In deciding whether to take the given action, individuals consider their perceived susceptibility to the given condition and the perceived severity of acquiring that condition. Second, individuals weigh the benefits of taking the health action against the barriers to taking that action. Finally, individuals must be cued to take the given action through either an internal cue (such as symptoms of a disease) or an external cue (such as illness of a family member or provider recommendation to take the action) (Becker, Don et al. 1977).

Applying this to influenza vaccination, the HBM predicts that in order for individuals to be vaccinated for influenza they must believe that they are vulnerable to acquiring influenza, must believe that the illness, if acquired, will be severe, and must feel that the benefits of obtaining the vaccine outweigh the barriers. In addition to these requirements, individuals must also experience a cue that triggers them to be vaccinated. In the case of influenza, cues may include witnessing a family member or close contact suffer from influenza, past, positive experience with the influenza vaccine, prior influenza illness, or belonging to a group that is targeted for vaccination such as healthcare workers.

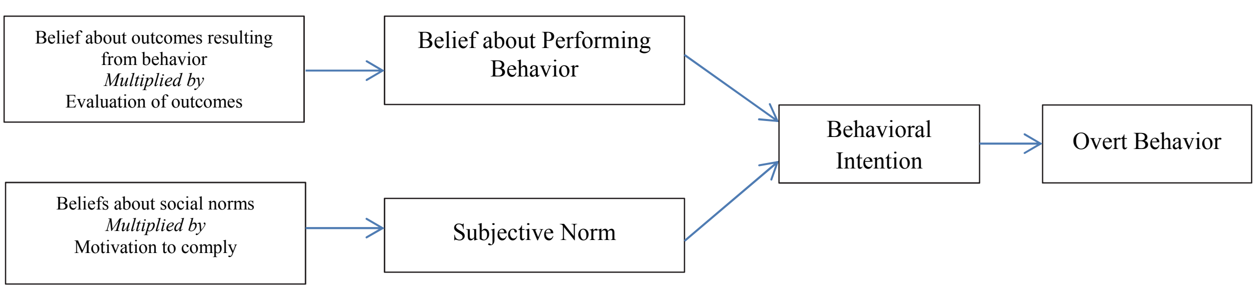
Figure 1. Health Belief Model (adapted from Becker et al., 1977 and Oliver & Berger 1979)



Behavioral Intention Model

Fishbein and Azjer (1975) proposed a model to predict behavioral intention (see Figure 2) (Fishbein and Ajzen 1975; Oliver and Berger 1979). They conclude that the best predictor of overt behavior is one's intention. It follows then that we need to model and understand behavioral intention to take up vaccination in order to predict overt influenza vaccine uptake. Intention to vaccinate has been found to be associated with influenza vaccine uptake (Harris, Maurer et al. 2009). Fishbein and Azjer propose that two factors determine one's behavioral intention: attitudes and social norms. They are careful to point out that attitudes and social norms are determined under a specific set of circumstances (Fishbein and Ajzen 1975). Tying this into influenza vaccination this points to the need to understand the circumstances surrounding an individual's decision to get vaccinated. In our model, we will consider the impact of personal and environmental characteristics in influencing attitudes, social norms, and the subsequent influenza vaccine decision. Fishbein and Azjer also incorporate one's evaluation of the given behavior's outcomes and one's motivation to comply with social norms into their model (Fishbein and Ajzen 1975). In the case of influenza vaccination, one might evaluate the likelihood of side effects from vaccination and the probability and severity of acquiring influenza.

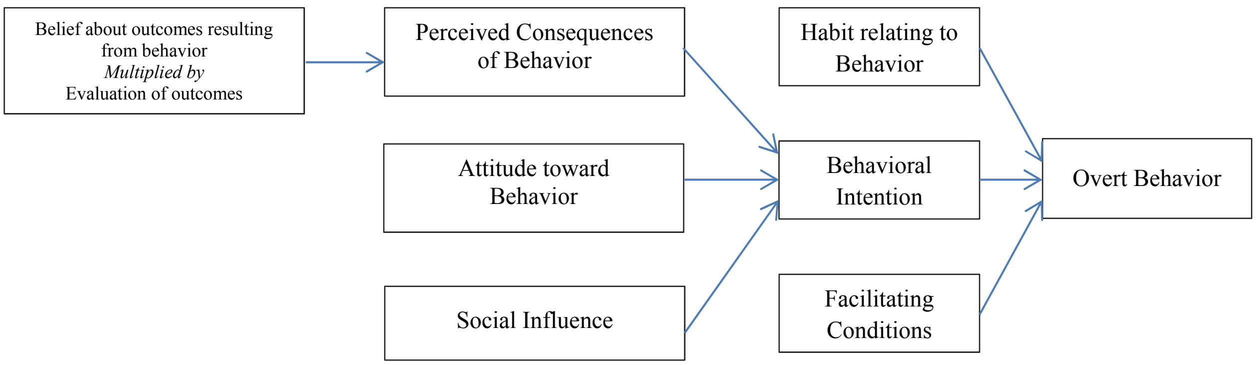
Figure 2. Behavioral Intention Model (Adapted from Fishbein and Azjer 1975 & Oliver and Berger 1979)



Model of Consumer Decision Making

The Triandis (1980) model of consumer decision making is in many ways similar to the Fishbein and Azjer model (see Figure 3). The Triandis model directly calls out facilitating conditions as a factor which determines behavior, as opposed to the Fishbein model which allows for facilitating conditions by pointing out that attitudes and perceived norms are a result of the circumstances in which a behavioral decision is made. Triandis also accounts for habit formation surrounding a behavior (Montano 1986). Given that influenza vaccination is a behavior that we would like people to take up yearly, habit formation is an important consideration.

Figure 3. Model of Consumer Decision Making (Derived from Montano 1986)



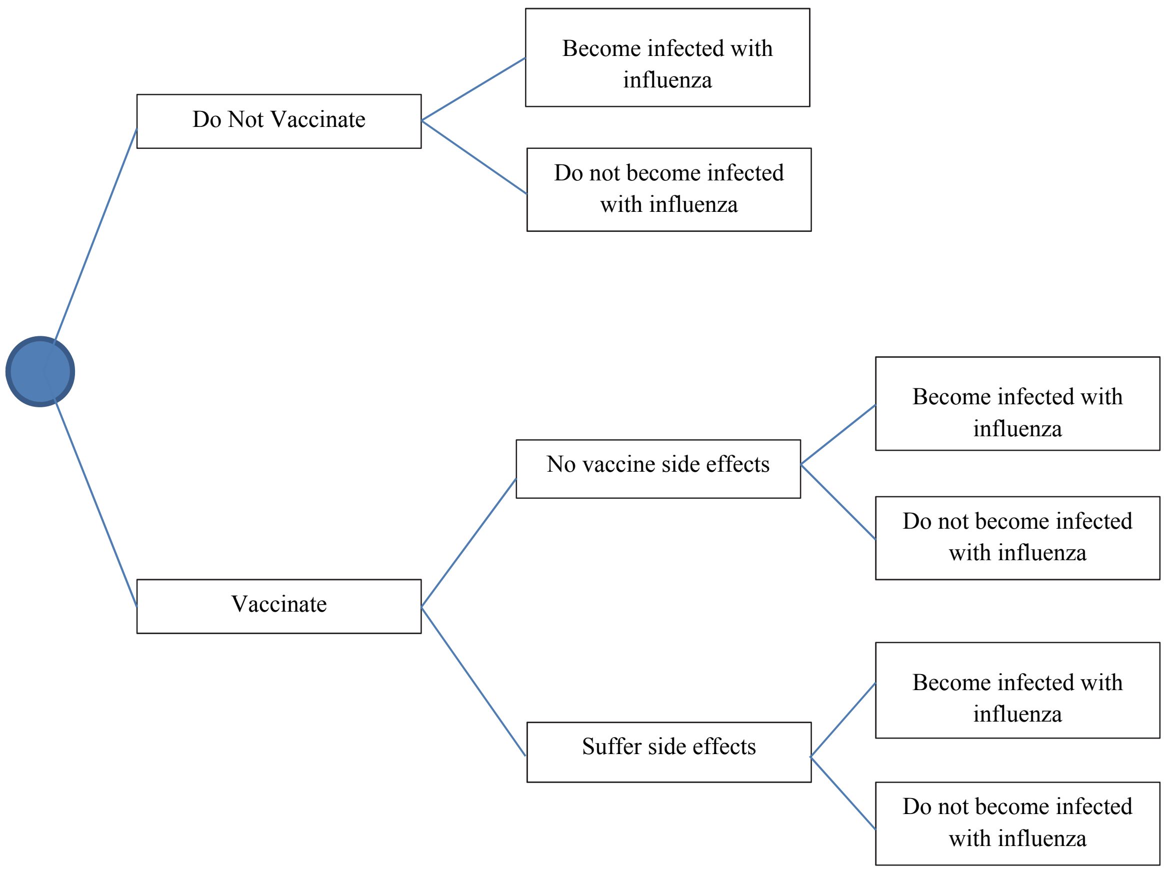
Application to Current Study

In framing our model of vaccine decision making, we draw on the Health Belief Model (Becker, Don et al. 1977); although, the argument could be made for tailoring any of the above described models to the influenza vaccine decision and we incorporate takeaway points from all three into the theoretical framework. The HBM is more easily interpreted in the context of vaccination because it has been applied in several studies examining the influenza vaccine decision (Oliver and Berger 1979; Nexøe, Kragstrup et al. 1999; Kwong, Pang et al. 2010). This model also has components that we identify as important in understanding the vaccine decision and important as potential levers for policies to focus on when trying to increase vaccine uptake that are not included in the other models considered. The components include perceived susceptibility and severity of influenza. We make some modifications, outlined in the next section, to the HBM in our framework. We begin with an economic model of the decision and then draw on the HBM to further explain the decision process described in the proposed utility model.

Economic Model for General Population

Shahrabani et al. (2008) propose an expected utility model for the vaccination decision which we build on here (Shahrabani, Gakni et al. 2008). The model can be understood by following the decision tree depicted in Figure 4.

Figure 4. Decision Tree for the Influenza Vaccination Decision



The decision model corresponding to this decision tree is as follows:

Let $U(h_i)$ = utility from health, for i = g, b (where g = no influenza state, b = influenza state),
p = perceived probability of contracting influenza in the absence of vaccination,
e = perceived effectiveness of the influenza vaccine (i.e., (1-e) represents the perceived probability of contracting influenza given vaccination),
s = perceived probability of vaccine side effects,
c = fixed cost of vaccination (monetary cost, disutility from vaccine),
l_s = cost of vaccine side effects,
l_f = non-utility cost of being sick with influenza (lost wages, medication), and
v = binary variable for vaccination, where 1 = vaccinated

Expected Utility if Vaccinated

$$E(U|v=1) = e(1-s)\left(U\left(h_g\right)-c\right) + (1-e)(1-s)\left(U(h_b)-c-l_f\right) + es\left(U\left(h_g\right)-c-l_s\right) + (1-e)s(U(h_b)-c-l_s-l_f)$$

Expected Utility if Not Vaccinated
$E(U|v=0) = (1-p)U(h_g) + p(U(h_b) - l_f)$

Decision Rule
Individuals choose to be vaccinated if E(U|v=1) > E(U|v=0).

With some manipulation of these equations (see Appendix 1), the decision rule becomes: Individuals choose to be vaccinated if

$$p^* > (1-e) + \frac{sl_s + c}{\Delta U(h) + l_f} \ ,$$

where p* represents the perceived probability of influenza in the absence of vaccination at which the individual will be just willing to be vaccinated, herein referred to as the threshold probability of influenza, and $\Delta U(h) = U(h_g) - U(h_b)$ (or the loss of utility from acquiring influenza).

We can label the terms in the decision rule as follows:

p = perceived probability of influenza | no vaccination
(1-e) = perceived probability of influenza | vaccination
$sl_s + c$ = expected cost of vaccination
 sl_s = expected cost of vaccine side effects
 c = fixed costs of vaccine (disutility of shot, monetary cost (missed time from work, travel to clinic, etc.))
$\Delta U(h) + l_f$ = cost of acquiring influenza

The decision rule indicates that individuals will be vaccinated if the perceived probability of acquiring influenza in the absence of vaccination is greater than the perceived probability of acquiring influenza given vaccination plus the ratio of expected vaccine cost to influenza cost. This decision rule leads to the following relationships: the threshold probability of acquiring influenza in the absence of vaccination is decreasing in perceived vaccine effectiveness and the cost of acquiring influenza, and is increasing in perceived probability of vaccine side effects and in the expected cost of vaccination.

Looking at a slightly different manipulation of the decision rule, we see that the expected cost of influenza conditional on not being vaccinated must be greater than the expected cost of influenza conditional on being vaccinated plus the expected cost of vaccination in order for individuals to take up the vaccine.

$$p(\Delta U(h) + l_f) > (1-e)(\Delta U(h) + l_f) + sl_s + c \ ,$$

Where $p(\Delta U(h) + l_f)$ = expected cost of influenza | no vaccination,
$(1\text{-}e)(\Delta U(h) + l_f)$ = expected cost of influenza | vaccination, and
$sl_s + c$ = expected cost of vaccination

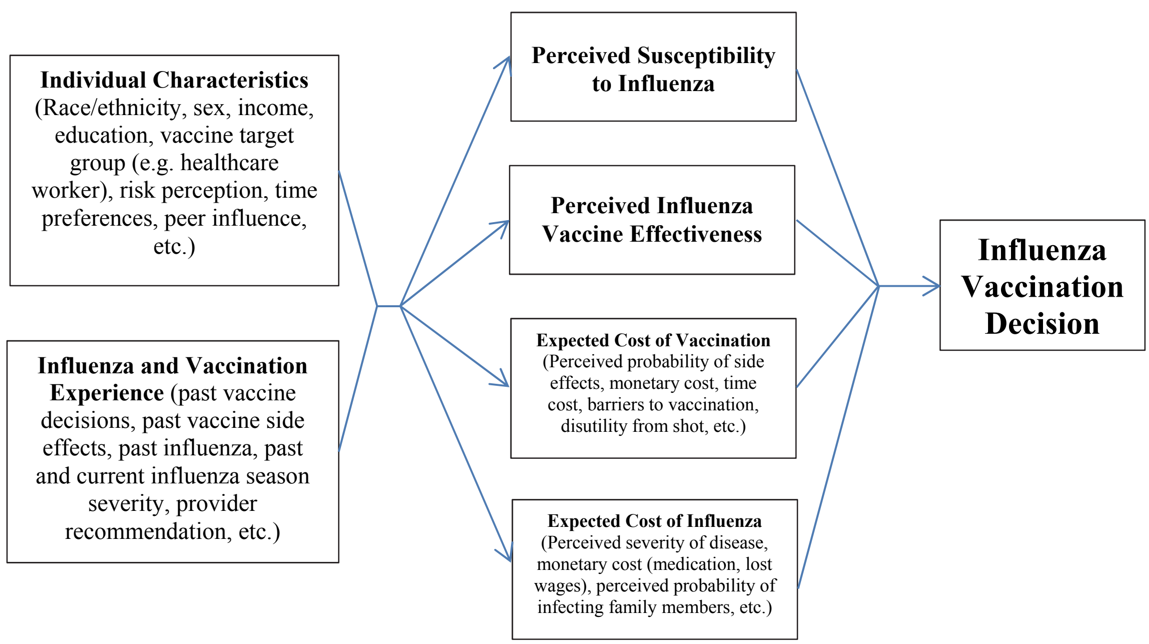
Vaccine Perceptions and Behavior Framework

We draw on Shahrabani et al. (2008) to point out that if individuals made the vaccine uptake decision based on true probabilities we would expect very high rates of vaccination (Shahrabani, Gakni et al. 2008). Based on their model and some assumptions about the cost of the vaccine, the cost of being sick with influenza, and the probability of vaccine effectiveness, Shahrabani et al. determine that the threshold probability of acquiring influenza in the absence of vaccination is $p^* = 0.12$ (Shahrabani, Gakni et al. 2008). So, if the probability of acquiring influenza is higher than this, then an individual will get vaccinated. The true influenza infection rate varies across seasons but is estimated at 1% to 26% for adults aged 18-64 (Bridges, Thompson et al. 2000). This suggests that there should be high vaccination rates among this population during most influenza seasons, although the vaccination rate among this group was only 38% during the 2009-2010 influenza season (Centers for Disease Control and Prevention 2010).

This discrepancy likely occurs because individuals make the influenza vaccine uptake decision based on their own perceptions of influenza susceptibility, influenza costs, vaccine effectiveness, and side effect likelihood. Given the low influenza vaccination rates seen in the U.S., it is clear that for many individuals their perceptions of these values differ from the true values.

We can draw on the models of health decision making in the psychology literature to understand how individuals reach these perceived values. In Figure 5, we propose a framework for understanding the perceptions about influenza and vaccination that lead to the vaccine decision.

Figure 5. Framework for Understanding Vaccine Perceptions and Vaccine Behavior



This framework can be seen as building off the Health Belief Model (Becker, et al., 1977) with modifications to fit with the expected utility model. Some key modifications of this framework compared to the HBM are:

- Cues to action: The cues to action piece which Becker et al. (1977) describe as a requirement to trigger the appropriate health behavior (in this case immunization) is captured in the Influenza and Vaccine Experience category (Becker, Don et al. 1977).
- Addition of past influenza and vaccine experience: The influenza vaccine, like many other preventative health behaviors, needs to be taken up more than once. This allows for past experience with the vaccine to impact the vaccine decision in the current time period. Likewise, influenza may be experienced multiple times and therefore past experience with the disease can influence the decision in the current period. Past experience may be considered a cue to action; although, if the experience was negative it may be a cue to inaction.
- Inclusion of vaccine target group under Individual Characteristics: This aligns with the HBM's demographic and sociopsychological factor. We intentionally call out vaccine target groups to focus on the groups of individuals targeted in the ACIP influenza vaccine recommendations. For example, healthcare workers, individuals aged 65 and older, and parents and caregivers of young children are specific targets of the ACIP recommendations (Fiore, Uyeki et al. 2010). It is important to identify these target groups in the model because they are targeted in order to protect individuals who are at high risk for influenza-related complications. Given this, the decision making process among these target groups may differ from the general population. This is relevant to policy makers because we want these individuals to recognize that they are a targeted group for vaccination and to have a higher likelihood of vaccine uptake.
- Demographic factors may impact cues to action: While Becker et al. (1977) note that "diverse demographic, personal, structural, and social factors can, in any given instance, affect an individual's health motivations and perceptions, these variables are not considered direct causes of health action (Becker, Don et al. 1977)." We reason that while these demographic and social factors are secondary to the influenza vaccine uptake decision they are very important in understanding which individuals are at risk for not taking up the vaccine. These secondary factors are of great value because we are able to identify target groups based on demographic factors more easily than based on individual perceptions.

3. Influenza Vaccination among Healthcare Professionals and Non-Healthcare Professionals: Do Children in the Household Matter?

Introduction

Working-aged adults with children in the household are not only at risk for spreading influenza to the children but are also at risk for contracting influenza from the children, because a common pathway for influenza transmission occurs from school to household (Viboud, Boelle et al. 2004). Household contacts of infected children are more likely to acquire influenza infection than household contacts of infected adults (Viboud, Boelle et al. 2004). The presence of children in the household takes on additional importance among healthcare professionals. Like all adults with children in the household, this group faces the risk of transmitting influenza to and contracting influenza from the children; however, this group is also at added risk of spreading influenza from the children at home to their patients at work and vice versa (Yassi, McGill et al. 1993; Salgado, Giannetta et al. 2004; Tsagris, Nika et al. 2012). The presence of children in the household may be a more important factor in the spread of influenza than the occupational risks faced by healthcare professionals. One study found a stronger association between the presence of children in the household and being sick with influenza than between employment as a healthcare professional and being sick with influenza (Williams, Schweiger et al. 2010).

Healthcare professionals and their employers are concerned about the spread of influenza from work to home and vice versa. Among the top reasons healthcare professionals have reported for receiving influenza vaccination are protecting one's family and protecting one's patients (Abramson and Levi 2008; Maltezou, Maragos et al. 2008; Dedoukou, Nikolopoulos et al. 2010). The employers of healthcare professionals and public health officials are also concerned about healthcare professionals transmitting influenza to the extent that mandatory influenza vaccination has been considered (van Delden, Ashcroft et al. 2008). As of 2005, 21 states had laws requiring employers to offer influenza vaccination to healthcare professionals and 15 states had laws requiring employers to ensure vaccination of healthcare professionals unless they refuse or are exempt (e.g., due to an allergy) (Lindley, Horlick et al. 2007).

While no studies have assessed the rates of influenza vaccination among adults with children in the household, low rates of influenza vaccination have been observed among healthcare professionals and the broader population of working-aged adults. Only 29 percent of adults aged 18 to 49, 42 percent of adults aged 50 to 64, and 67 percent of healthcare professionals were vaccinated for influenza during the 2011-2012 influenza season (Centers for Disease Control and Prevention 2012; Centers for Disease Control and Prevention 2012). These rates of vaccination are well below the Healthy People 2020 goal vaccination rates for working aged adults of 80-90 percent (U.S. Department of Health and Human Services 2012).

While the presence of children in the household is important to the spread of influenza, the impact of children in the household on influenza vaccine uptake among working-aged adults has not been explored previously. The current study used non-publically available data from nationally representative surveys to assess the impact of children in the household on influenza vaccine uptake among healthcare professionals and other working-aged adults during the 2008-2009 and 2009-2010 influenza seasons.

Model and Predictions

Shahraban, Gakni, and Ben-Zion (2008) propose an economic model of influenza vaccination. Modifying their model to include the cost to be vaccinated, we conclude that individuals will be vaccinated for influenza if the expected cost of influenza infection in the absence of vaccination exceeds the expected cost of influenza infection in the presence of vaccination plus the expected cost of vaccination (for a full explanation of the model see the Vaccine Model section). The expected cost of influenza includes lost utility due to illness as well as non-utility costs such as lost wages or medical treatment. The expected cost of influenza is also a function of exposure and susceptibility to the influenza virus. Susceptibility to the virus differs depending on individual characteristics and vaccine status. The expected cost of vaccination includes monetary and time costs required to be vaccinated and the cost of vaccine side effects. Shahrabani, Gakni, and Ben-Zion (2008) found that their model predicted higher influenza vaccination rates than we actually see in practice when they included estimates of the true values for all variables (e.g, susceptibility to influenza) in the model. This indicates that individual's perceived values of the variables in the model differ from the true values. Individuals may be unaware of their susceptibility or exposure to influenza, may underestimate the effectiveness of influenza vaccines, or may overestimate the cost and probability of vaccine side effects.

Healthcare Professionals

In practice, healthcare professionals are vaccinated for influenza at higher rates than non-healthcare professionals (Centers for Disease Control and Prevention 2011; Centers for Disease Control and Prevention 2011). The model for the influenza vaccine decision proposed above would also predict higher rates of vaccination for healthcare professionals for several reasons. Healthcare professionals have a higher risk of exposure to influenza at work than non-healthcare professionals. Given their educational background and experience, healthcare professionals are likely to have greater awareness of their exposure risk as well as a greater knowledge of the costs of being sick with influenza. Healthcare professionals are also concerned about infecting their patients or personal contacts and are likely to factor this into their vaccine decision.

Adults with Children in the Household

The model for the influenza vaccine decision predicts higher rates of influenza vaccination among parents than among non-parents because household contacts of children infected with influenza are more likely to acquire influenza infection than household contacts of infected adults (Viboud, Boelle et al. 2004). This puts adults with children in the household at a greater risk for influenza virus exposure than other adults. Adults with children in the household are also likely to consider the risk of transmitting influenza to the children in their household when deciding whether to be vaccinated.

Healthcare Professionals with Children in the Household

Healthcare professionals with children in the household are predicted to be more likely to be vaccinated for influenza than healthcare professions without children in the household and non-healthcare professionals with children in the household. This holds because healthcare professionals with children in the household face the risks for exposure to influenza at home and at work, and healthcare professionals with children in the household may be concerned with transmitting influenza to their patients and the children at home (Abramson and Levi 2008; Maltezou, Maragos et al. 2008; Dedoukou, Nikolopoulos et al. 2010).

Pandemic Influenza Season
During a pandemic influenza season, we predict higher vaccination rates for all adults. The susceptibility to pandemic influenza is higher than to seasonal influenza because the population has not been exposed to pandemic influenza and therefore no immunity has developed (Potter 2001). Among parents and non-parents this will increase the probability of contracting influenza in the absence of vaccination compared to a typical influenza season. Among healthcare professionals and adults with children in the household, however, there is also a greater transmission risk to patients or children at home. According to the model, this will result in a larger increase in vaccination rates among healthcare professionals than non-healthcare professionals and among parents than non-parents. Again here, healthcare professionals with children in the household face the risk of transmitting influenza to and acquiring influenza from both patients and children at home; therefore, we predict healthcare professionals with children in the household will have higher rates of pandemic influenza vaccination than non-healthcare professionals with children in the household and healthcare professionals without children in the household.

Methods

Data
This study used cross-sectional data from two nationally representative surveys of adults collected at the end of the 2008-2009 and 2009-2010 influenza seasons conducted by Knowledge Networks (currently known as GfK). The data were collected among nationally representative online panels of adults aged 18 and older between March 4, 2009 and April 7, 2009 for the 2009 survey and between March 4, 2010 and March 24, 2010 for the 2010 survey. Knowledge Networks composed their panel using a probability sample which captured households with and without Internet access. Internet access was provided to participants without access (Knowledge Networks 2012). The surveys oversampled African Americans, Hispanic Americans, and adults aged 65 and older in order to obtain a distribution of participants that was diverse in terms of age and ethnicity. The 2009 survey also oversampled healthcare workers. The surveys asked questions about the respondents' experiences with influenza vaccination during the 2008-2009 and 2009-2010 influenza seasons and about their general experiences with vaccination against other infectious diseases.

Subgroups
The data were split into two populations:

- Healthcare Professionals: Respondents who self-identified as being a healthcare professional or currently training to become a healthcare professional and who reported current employment (referred to throughout as healthcare professionals).
- Non-Healthcare Professionals: Respondents who did not self-identify as being a healthcare professional and who reported current employment (referred to throughout as non-healthcare professionals).

Non-healthcare professionals were used as a comparison group to determine if outcomes for healthcare professionals were different from the broader population. The sample of healthcare professionals included 1,418 respondents from the 2009 survey and 165 respondents from the

2010 survey. The sample of non-healthcare professionals included 1,951 respondents from the 2009 survey and 1,683 respondents from the 2010 survey. The larger sample size of healthcare professionals in the 2009 survey is the result of oversampling of this group.

Outcome Variables
There were three vaccination outcomes of interest:

- Self-reported seasonal influenza vaccination during the 2008-2009 influenza season
- Self-reported seasonal influenza vaccination during the 2009-2010 influenza season
- Self-reported H1N1 influenza vaccination during the 2009-2010 influenza season

Vaccination status was assessed by the question "Did you get a flu vaccine this past flu season (September 2008 to March 2009)?" in the 2009 survey and the questions "Did you get a seasonal flu vaccine this past flu season (August 2009 to March 2010)?" and "Have you received a H1N1/Swine flu vaccine this flu season?" in the 2010 survey.

Respondent's attitudes about influenza and vaccination were also included as outcome variables in the analysis. Where the same attitude statements were assessed across both surveys, models were assessed for the 2008-2009 and 2009-2010 influenza seasons. Statements assessed for both influenza seasons included:

- "Flu vaccines cause people to get the flu."
- "In general, vaccines are safe."

The 2010 survey also assessed attitudes specific to seasonal or H1N1 influenza. Statements assessed only for the 2009-2010 influenza season included:

- "Seasonal (H1N1/swine) flu is a serious disease."
- "Seasonal (H1N1/swine) flu vaccination is worth the time and expense."

For all statements, respondents indicated agreement on a 5-point Likert scale that ranged from strongly agree to strongly disagree. Responses were collapsed into two groups: (1) strongly agree or agree and (2) neutral, disagree, or strongly disagree. Neutral responses were grouped with disagree and strongly disagree because in general the statements are true. Therefore, grouping the responses in this way separates individuals who were knowledgeable about influenza and influenza vaccination from those who were not. This was reversed for the statement "Flu vaccines cause people to get the flu." where responses were collapsed to (1) strongly disagree or disagree and (2) neutral, agree, or strongly agree.

Covariates
The main covariate of interest was self-report of presence of children in the household. Respondents who reported having at least one member of the household under the age of 18 were included in the "children in the household" group.

Indicator variables for groups recommended for influenza vaccination by the ACIP were also included for seasonal and H1N1 influenza based on the respondent's self-reported age, high-risk conditions (e.g., asthma), pregnancy, close contact with adults aged 50 and older, and outside of the home contact with children under the age of five (Fiore, Shay et al. 2008; Centers for Disease Control and Prevention 2009; Fiore, Shay et al. 2009). The ACIP recommended groups for seasonal influenza vaccination were consistent between the 2008-2009 and 2009-2010 influenza seasons but differed for H1N1 influenza vaccination in 2009-2010. The ACIP recommended groups were included as individual controls in the regression analyses described in the analysis section in addition to sociodemographic covariates (race, sex, age, education level, household income, health insurance status, and region of residence).

Analysis
The 2008-2009 influenza season was a non-pandemic influenza season during which only seasonal influenza was circulating. The 2009-2010 influenza season, however, was a pandemic influenza season during which both seasonal and H1N1 (pandemic) influenza were circulating. In this influenza season, separate vaccines were required for seasonal and H1N1 influenza. Given the differing nature of the two influenza seasons, the two seasons were analyzed separately. This allowed for inferences to be made regarding the vaccine decision during a typical influenza season and during a pandemic influenza season. A priori, it was not clear whether individuals would act similarly across both influenza seasons.

The 2008-2009 seasonal influenza, 2009-2010 seasonal influenza, and 2009-2010 H1N1 influenza vaccination rates were compared for healthcare professionals and non-healthcare professionals and for those with and without children in the household using Wald tests to determine group differences.

To determine whether influenza vaccination uptake should be modeled separately for healthcare professionals and non-healthcare professionals, tests for structural change were conducted for 2008-2009 seasonal influenza, 2009-2010 seasonal influenza, and 2009-2010 H1N1 influenza vaccine uptake. The test for structural change uses a Gauss-Newton regression test the fully-interacted model against the pooled model (MacKinnon 1989; Mackinnon 1992). The results indicated that 2008-2009 seasonal influenza should be modeled using a fully-interacted model but 2009-2010 seasonal influenza and 2009-2010 H1N1 influenza should be modeled using a pooled model. Given the discrepancy, both pooled and fully interacted models were run for all three types of influenza. Results were consistent in terms of direction, and magnitude. In a few instances, there was a difference in significance but even in those cases the direction and magnitude were consistent. For ease of interpretation, all results presented here are from fully-interacted models for seasonal influenza and H1N1 influenza.

The impact of children in the household on influenza vaccination and on attitudes about influenza during the 2008-2009 and 2009-2010 influenza seasons was assessed by estimating univariate probit models. The impact of children in the household on seasonal and H1N1 influenza vaccination and on attitudes about both types of influenza during the 2009-2010 influenza season was also assessed by estimating bivariate probit models. The bivariate probit modeling strategy was used to reduce possible bias from unobservable inputs that affected both seasonal and H1N1 influenza vaccine decisions and attitudes, such as perceived cost of infecting a family member. All models controlled for sociodemographic characteristics and influenza-type specific ACIP recommendations. The bivariate probit model for seasonal and H1N1 influenza vaccination is:

$$seasonal\ influenza\ vaccination^* = hcp\beta_{1a} + X_1\beta_{1b} + (X_1 * hcp)\beta_{1c} + \varepsilon_1,$$
$$if\ seasonal\ influenza\ vaccination^* > 0, 0\ otherwise$$

$$H1N1\ influenza\ vaccination^* = hcp\beta_{2a} + X_1\beta_{2b} + (X_1 * hcp)\beta_{2c} + \varepsilon_2,$$
$$if H1N1\ influenza\ vaccination^* > 0, 0\ otherwise$$

$$E[\varepsilon_1|x_1, x_2] = E[\varepsilon_2|x_1, x_2] = 0$$
$$Var[\varepsilon_1|x_1, x_2] = Var[\varepsilon_2|x_1, x_2] = 1$$
$$Cov[\varepsilon_1, \varepsilon_2|x_1, x_2] = \rho$$

Where β_{1a} and β_{2a} represent the coefficients on hcp (indicator for healthcare professional); β_{1b} represents a vector of regression coefficients corresponding to the covariates X_1 (which include presence of children in household, race (Black, Hispanic, and other race compared to White), sex, age (aged 25-39, 40-49, and 50 or older compared to aged 18-24), education level (some college, college or higher, compared to high school degree or less), household income, health insurance coverage, region of residence (South, Midwest, and West compared to Northeast), metro-area residence, and indicators for groups recommended for seasonal influenza vaccination by the ACIP (described in detail above); β_{1c} represents a vector of coefficients corresponding to the covariates X_1 interacted with the hcp indicator; β_{2b} represents a vector of regression coefficients corresponding to the covariates X_2 (which includes the same variables as the X_1 vector except indicators for groups recommended for H1N1 influenza vaccination by the ACIP are substituted for the seasonal influenza recommended groups); and β_{2c} represents a vector of regression coefficients corresponding to the covariates X_2 interacted with the hcp indicator.

All analyses were conducted using STATA/IC 11 (StataCorp, College Station, TX). In order to generate nationally representative estimates, post-stratification weights were used. Standard errors were calculated using a Taylor series linearization method in order to account for potential arbitrary heteroskedasticity in the distribution of the errors. Marginal effects based on the univariate and bivariate probit models were calculated using STATA's margins command. To account for underlying differences in vaccination rates and attitudes between healthcare professionals and non-healthcare professionals, percent change in the respective outcome was calculated by dividing the marginal effect by the respective rate for the baseline group (i.e., healthcare professionals with no children in the household or non-healthcare professionals with no children in the household). For example, the marginal effect of children in the household on seasonal influenza vaccination among healthcare professionals was divided by the rate of seasonal influenza vaccination among healthcare professionals with no children in the household.

Results

Sample Characteristics

Sample characteristics for both groups in both years of data are summarized in Table 1. In the 2008-2009 sample, more healthcare professionals had children in the household (34.05% versus 24.34%), were female (73.25% versus 43.70%), were Black (16.68% versus 10.50%), attained a college degree or higher (44.43% versus 32.72%), earned $100,000 per year or more (26.66% versus 15.98%), and lived in the Midwest (32.39% versus 22.18%) than non-healthcare professionals. Also in the 2008-2009 sample, fewer healthcare professionals attained a high school diploma or less education (21.83% versus 37.91%), earned between $25,000 and $49,999 (20.00% versus 27.48%), and lived in the West than non-healthcare professionals (16.44% versus 26.07%). In the 2009-2010 sample, fewer healthcare professionals were aged 40 to 49 (13.11% versus 25.78%) and lived in the West (15.09% versus 25.83%). There were no other significant differences between the healthcare professional and non-healthcare professional samples.

Vaccination Rates
During the 2008-2009 influenza season, significantly more healthcare professionals were vaccinated for seasonal influenza than non-healthcare professionals (53.05% vs. 27.60%, $p \leq 0.001$; Table 2). The same pattern held for seasonal influenza vaccination (60.80% vs.31.76%, $p \leq 0.001$) and H1N1 influenza vaccination (48.04% vs. 17.11%, $p \leq 0.001$) during the 2009-2010 influenza season.

Within the group of healthcare professionals, there was no significant difference in the rate of seasonal influenza vaccination among respondents with children in the household compared to respondents without children in the household during the 2008-2009 and 2009-2010 influenza seasons. The rate of H1N1 influenza vaccination was significantly higher among healthcare professionals with children in the household then among healthcare professionals with no children in the household (69.43 vs. 34.12, $p \leq 0.05$). There were no significant differences in seasonal influenza vaccination during either influenza season or H1N1 influenza vaccination among non-healthcare professionals with children in the household compared to those without children in the household.

Association between Children in Household and Influenza Vaccination
Based on the univariate probit models, during the 2008-2009 and 2009-2010 influenza seasons, the presence of children in the household was not associated with seasonal influenza vaccination among healthcare professionals or non-healthcare professionals (Table 3). During the 2009-2010 influenza season, the presence of children in the household was associated with a 27.42 percentage point increase in H1N1 influenza vaccination among healthcare professionals ($p \leq 0.05$). This corresponded to a 80.36 percent change in the vaccination rate among healthcare professionals with children in the household compared to healthcare professionals without children in the household. Among non-healthcare professionals, there was no association between children in the household and H1N1 influenza vaccination.

The bivariate probit model results also indicated an association between children in the household and H1N1 influenza vaccination among healthcare professionals (Table 4). During the 2009-2010 influenza season, presence of children in the household was associated with a 17.19 percentage point increase in receiving seasonal and H1N1 influenza vaccination ($p \leq 0.05$) and a 11.74 percentage point increase in receiving only H1N1 influenza vaccination among healthcare professionals ($p \leq 0.05$). This corresponded to a 56.70 percent change and a 306.53 percent change, respectively, in the rates of vaccination among healthcare professionals with children in the household compared to healthcare professionals with no children in the household. Also consistent with the univariate model, the bivariate probit model indicated no effect of children in the household on influenza vaccination among non-healthcare professionals.

Association between Children in Household and Attitudes about Influenza and Vaccination
During the 2008-2009 and 2009-2010 influenza seasons there was no association between children in the household and agreement with “In general, vaccines are safe.” or disagreement with “Flu vaccines cause the flu.” among healthcare professionals (table omitted for brevity). Among non-healthcare professionals there was no association between children in the household and disagreement with “Flu vaccines cause the flu.” during either influenza season. There was a positive association between children in the household and agreement with “In general, vaccines are safe.” among non-healthcare professionals during the 2008-2009 influenza season (marginal effect 10.07, $p \leq 0.05$; table omitted for brevity); although, no significant association was seen during the 2009-2010 influenza season.

During the 2009-2010 influenza season, presence of children in the household was associated with an 18.29 percentage point increase in agreement that any type of influenza (seasonal or H1N1) is a serious disease and a 20.76 percentage point increase in agreement that both seasonal and H1N1 influenza are serious diseases among healthcare professionals ($p \leq 0.05$ for both; Table 5). This corresponded to a 29.48 percentage point change and a 58.89 percentage point change, respectively, in the rate of agreement among healthcare professionals with children in the household compared to healthcare professionals without children in the household. Among non-healthcare professionals, there was association between presence of children in the household and agreement with “Seasonal (H1N1/swine) influenza is a serious disease.” Among healthcare professionals, presence of children in the household was associated with a 9.62 percentage point decrease in agreement that only seasonal influenza vaccination is worth the time and expense and a 7.91 percentage point increase in agreement that only H1N1 influenza vaccination is worth the time and expense ($p \leq 0.05$ for both; Table 6). This corresponded to a 81.18 percentage point change and a 345.42 percentage point change respectively. Among non-healthcare professionals there was no association between presence of children in the household and agreement with “Seasonal (H1N1/swine) influenza vaccination is worth the time and expense.”

Table 1. Characteristics of Healthcare Professionals and Non-Healthcare Professionals

	2008-2009 Survey		2009-2010 Survey	
	Healthcare Professionals % (95% CI)	Non-Healthcare Professionals % (95% CI)	Healthcare Professionals % (95% CI)	Non-Healthcare Professionals % (95% CI)
Age (years)				
18-24	14.27 (7.17, 21.37)	9.71 (7.16, 12.27)	14.49 (2.97, 26.01)	10.95 (8.03, 13.88)
25-39	35.75 (29.24, 42.25)	33.35 (29.13, 37.57)	41.95 (25.81, 58.08)	33.11 (28.92, 37.30)
40-49	23.86 (18.12, 29.59)	26.80 (22.87, 30.74)	13.11* (4.75, 21.48)	25.78 (21.86, 39.67)
50 or older	26.12 (20.64, 31.61)	30.14 (27.00, 33.27)	30.45 (19.75, 41.15)	30.16 (27.04, 33.28)
Children in the Household				
Yes	34.05* (27.81, 40.29)	24.34 (20.68, 28.01)	39.64 (24.54, 54.74)	35.55 (31.42, 39.76)
Educational Attainment				
High School Diploma or Less	21.83* (13.83, 29.83)	37.91 (33.80, 42.03)	27.29 (14.23, 40.35)	34.28 (30.20, 38.37)
Some College	33.74 (27.85, 39.64)	29.37 (25.57, 33.17)	39.47 (24.77, 54.16)	30.46 (26.58, 34.34)
College or Higher	44.43* (37.59, 51.26)	32.72 (28.94, 36.49)	33.24 (18.45, 48.03)	35.26 (31.41, 39.11)
Health Insurance				
Insured	87.59 (81.49, 93.68)	82.07 (78.60, 85.54)	89.93 (81.51, 98.36)	81.03 (77.46, 84.60)
Household Income				
less than $25,000	16.32 (8.66, 23.98)	13.60 (10.56, 16.63)	11.18 (2.70, 19.66)	12.73 (9.79, 15.67)
$25,000 to less than $50,000	20.00* (13.80, 26.19)	27.48 (23.70, 31.26)	23.86 (11.62, 36.12)	23.82 (20.25, 27.37)
$50,000 to less than $100,000	37.02 (31.00, 43.04)	42.94 (38.83, 47.06)	44.38 (28.73, 60.02)	43.08 (38.94, 47.22)
$100,000 or greater	26.66* (21.13, 32.20)	15.98 (13.19, 18.76)	20.58 (11.04, 30.12)	20.37 (17.15, 23.59)
Race				
Black	16.68* (11.25, 22.11)	10.50 (8.64, 12.36)	14.05 (8.17, 19.94)	8.17 (6.55, 9.79)
Hispanic	8.41 (3.86, 12.96)	12.74 (10.25, 15.24)	8.05 (-0.17, 16.26)	12.65 (9.90, 15.41)
White	69.51 (62.96, 76.06)	69.78 (66.37, 73.18)	71.12 (59.82, 82.43)	72.70 (69.19, 76.20)
Other Race	5.40 (3.51, 7.30)	6.98 (5.25, 8.70)	6.78 (1.73, 11.83)	6.48 (4.46, 8.50)
Region				
Northeast	18.89 (12.80, 24.98)	16.81 (13.68, 19.94)	16.04 (6.15, 25.93)	18.64 (15.44, 21.83)
Midwest	32.39* (26.04, 38.74)	22.18 (18.54, 25.81)	34.63 (18.21, 51.04)	20.12 (16.67, 23.57)
South	32.28 (25.44, 39.11)	34.94 (31.04, 38.85)	34.24 (20.95, 47.54)	35.37 (31.42, 39.32)
West	16.44* (11.86, 21.03)	26.07 (22.47, 29.67)	15.09* (6.59, 23.59)	25.87 (22.18, 29.56)
Sex				
Female	73.25* (65.61, 80.89)	43.70 (39.58, 47.81)	60.36 (45.91, 74.80)	47.30 (43.12, 51.47)
Metro Residence				
Metro	82.42 (75.14, 89.69)	85.01 (81.87, 88.15)	86.97 (78.49, 95.45)	84.51 (81.42, 87.60)

† All estimates weighted to be nationally representative using data from the Current Population Survey

§ The sample size for healthcare professionals was 1,414 in 2008-2009 and was 164 in 2009-2010. Throughout, differences in sample sizes across models are the result of missing observations for one or more variables used in the model.

†† The sample size for non- healthcare professionals was 1,943 in 2008-2009 and was 1,675 in 2009-2010.

* Differs significantly from non-healthcare professional group

Table 2. Influenza Vaccination Rates among Healthcare Professionals and Non-Healthcare Professionals during the 2008-2009 and 2009-2010 Influenza Seasons

	2008 - 2009			2009 - 2010				
	Seasonal influenza			Seasonal influenza			H1N1 influenza	
	N	Weighted % (95% CI)†		N	Weighted % (95% CI)†		Weighted % (95% CI)†	
Healthcare Professionals	1,418	53.05	(45.94, 60.15)‡	165	60.80	(46.69, 74.91)‡	48.04	(32.93, 63.16)‡
Children in household	468	52.27	(41.83, 62.72)	47	53.20	(28.08, 78.32)	69.43	(50.30, 88.57)§
No children in household	950	53.45	(44.13, 62.76)	118	65.75	(49.76, 81.73)	34.12	(17.89, 50.36)
Non-Healthcare Professionals	1,951	27.60	(24.15, 31.04)	1,683	31.76	(28.00, 35.52)	17.11	(14.12, 20.09)
Children in household	421	28.86	(21.18, 36.54)	480	30.37	(23.51, 37.22)	14.36	(9.90, 18.81)
No children in household	1,530	27.19	(23.36, 31.02)	1,203	32.54	(28.09, 36.98)	18.63	(14.74, 22.52)

† All estimates weighted to be nationally representative using data from the Current Population Survey.

‡ Rate differs significantly from rate among non-healthcare professionals ($p \leq 0.05$)

§ Rate differs significantly from rate among healthcare professionals with no children in the household ($p \leq 0.05$)

Table 3. Impact of Children in the Household on Influenza Vaccination during the 2008-2009 and 2009-2010 Influenza Seasons†‡

	2008-2009		2009-2010			
	Seasonal Influenza Vaccination		Seasonal Influenza Vaccination		H1N1 Influenza Vaccination	
	Percentage Point Increase (95% CI)§	Percent Change	Percentage Point Increase (95% CI)§	Percent Change	Percentage Point Increase (95% CI)§	Percent Change
Health Care Professionals						
Children in household	1.14 (-7.95, 10.22)	2.13	1.57 (-18.30, 21.43)	2.39	27.42* (7.02, 47.83)	80.36*
Non-Health Care Professionals						
Children in household	8.80 (-0.13, 17.73)	32.36	1.73 (-6.30, 9.76)	5.32	-3.43 (-9.87, 3.02)	-18.41

† Percent change from probit models for influenza vaccine uptake adjusted for respondent's race, sex, age, education level, household income, insurance status, region (Northeast, South, Midwest, and West), metro residence, and influenza-type specific ACIP recommended groups conditional on being employed

‡The sample size was 3,326 in 2008-2009 and was 1,823 for the seasonal influenza model and 1,819 for the H1N1 influenza model during 2009-2010. Throughout, differences in sample sizes across models are the result of missing observations for one or more variables used in the model

§ All estimates weighted to be nationally representative using data from the Current Population Survey

* $p \leq 0.05$

Table 4. Impact of Children in the Household on Seasonal and H1N1 Influenza Vaccination during the 2009-2010 Influenza Season†‡

	Any type of influenza vaccination		Seasonal and H1N1		Seasonal Only		H1N1 Only	
	Percentage Point Increase (95% CI)§	Percent Change	Percentage Point Increase (95% CI)§	Percent Change	Percentage Point Increase (95% CI)§	Percent Change	Percentage Point Increase (95% CI)§	Percent Change
Employed Health Care Professionals								
Children in household	17.02 (-4.06, 38.11)	24.46	17.19* (-0.03, 34.42)	56.70*	-11.92 (-25.70, 1.86)	-33.64	11.74* (3.28, 20.21)	306.53*
Employed Non-HCP								
Children in household	0.17 (-7.83, 8.16)	0.47	-1.42 (-6.29, 3.45)	-9.50	3.00 (-3.08, 9.09)	16.93	-1.42 (-3.80, .096)	-38.27

† Partial effect from a bivariate probit model for seasonal and H1N1 influenza vaccine uptake adjusted for respondent's race, sex, age, education level, household income, insurance status, region (Northeast, South, Midwest, and West), metro residence, and influenza-type specific ACIP recommended groups conditional on being employed

‡ The sample size was 1,817. Throughout, differences in sample sizes across models are the result of missing observations for one or more variables used in the model.

§ All estimates weighted to be nationally representative using data from the Current Population Survey

* $p \leq 0.05$

Table 5. Agreement with "Seasonal (H1N1/swine) influenza is a serious disease." during the 2009-2010 Influenza Season†‡

	Any type of influenza vaccination		Seasonal and H1N1		Seasonal Only		H1N1 Only	
	Percentage Point Increase (95% CI)§	Percent Change	Percentage Point Increase (95% CI)§	Percent Change	Percentage Point Increase (95% CI)§	Percent Change	Percentage Point Increase (95% CI)§	Percent Change
Employed Health Care Professionals								
Children in household	17.02	24.46	17.19*	56.70*	-11.92	-33.64	11.74*	306.53*
	(-4.06, 38.11)		(-0.03, 34.42)		(-25.70, 1.86)		(3.28, 20.21)	
Employed Non-HCP								
Children in household	0.17	0.47	-1.42	-9.50	3.00	16.93	-1.42	-38.27
	(-7.83, 8.16)		(-6.29, 3.45)		(-3.08, 9.09)		(-3.80, .096)	

† Partial effect from a bivariate probit model for seasonal and H1N1 influenza vaccine uptake adjusted for respondent's race, sex, age, education level, household income, insurance status, region (Northeast, South, Midwest, and West), metro residence, and influenza-type specific ACIP recommended groups conditional on being employed

‡ The sample size was 1,817. Throughout, differences in sample sizes across models are the result of missing observations for one or more variables used in the model.

§ All estimates weighted to be nationally representative using data from the Current Population Survey

* $p \leq 0.05$

Table 6. Agreement with "Being vaccinated against Seasonal (H1N1/swine) influenza is worth the time and expense." during the 2009-2010 Influenza Season†‡

	Agree that any type of influenza vaccine is worth time and expense		Agree that seasonal and H1N1 influenza vaccination are worth time and expense		Agree that seasonal influenza vaccination only is worth time and expense		Agree that H1N1 influenza vaccination only is worth time and expense	
	Percentage Point Increase (95% CI)§	Percent Change	Percentage Point Increase (95% CI)§	Percent Change	Percentage Point Increase (95% CI)§	Percent Change	Percentage Point Increase (95% CI)§	Percent Change
Health Care Professionals§								
Children in household	2.52 (-17.63, 22.67)	3.73	4.22 (-14.33, 22.77)	7.90	-9.62* (-17.13, -2.10)	-81.18*	7.91* (1.64, 14.19)	345.42*
Non-Health Care Professionals††								
Children in household	-3.29 (-11.58, 5.00)	-6.76	-3.83 (-10.68, 3.01)	-12.74	3.10 (-1.62, 7.83)	28.52	-2.56 (-5.51, 0.39)	-33.07

† Percent change from a bivariate probit model for agreement that seasonal and H1N1 influenza vaccination are worth the time and expense adjusted for respondent's race, sex, education level, household income, insurance status, region(Northeast, South, Midwest, and West), metro residence, and ACIP recommended groups conditional on being employed

‡ The sample size was 1,806. Throughout, differences in sample sizes across models are the result of missing observations for one or more variables used in the model.

§ All estimates weighted to be nationally representative using data from the Current Population Survey

* $p \leq 0.05$

Discussion

This study found that there is a relationship between children in the household and influenza vaccination that is unique to healthcare professionals and H1N1 influenza vaccination. There was a positive association between children in the household and H1N1 influenza vaccination among healthcare professionals. This association was not seen among non-healthcare professionals. Although, we saw that healthcare professionals with children in the household were more likely to take up both seasonal and H1N1 influenza vaccines in the model predicting both outcomes, it seems likely that this association was really driven by uptake of H1N1 influenza vaccine. In practice, very few individuals received the H1N1 influenza vaccine without also receiving the seasonal influenza vaccine (Centers for Disease Control and Prevention 2010). This indicates that while many healthcare professionals may have taken up the seasonal influenza vaccine, healthcare professionals with children in the household were more likely to agree to receipt of the H1N1 influenza vaccine in addition to the seasonal influenza vaccine.

Based on the theoretical model presented above, we would have expected higher rates of influenza vaccination among parents across the entire population with a larger effect size among healthcare professionals, if parents were internalizing their true likelihood of exposure and susceptibility to the virus, the true likelihood of infecting their child with the virus, and the true costs of being sick with influenza. The results indicate that the theoretical model predictions bear out only for H1N1 influenza vaccination among healthcare professionals.

One plausible reason why uptake of H1N1 influenza vaccination differed among healthcare professionals with children in the household compared to healthcare professionals without children in the household is the shortage of H1N1 influenza vaccine that occurred from October 2009 through December 2009. Prior to release of any H1N1 influenza vaccines, the CDC identified populations to target for H1N1 influenza vaccination. Both healthcare professionals and children were included in the initial target group (Centers for Disease Control and Prevention 2010). The first doses of H1N1 vaccine became available in October 2009 but by October 21, 2009 only 12.8 million doses had been made available (U.S. Department of Health and Human Services Office of the Assistant Secretary for Preparedness and Response 2012). Given the early limited supply of the H1N1 influenza vaccine, the CDC further reduced the target populations to what they identified as a limited vaccine subset. The subset group still included healthcare professionals but only included children aged six months to four years and older children with chronic illnesses (Centers for Disease Control and Prevention 2010). When the first doses of vaccine were distributed in October, they were in the form of live attenuated influenza vaccine (LAIV) and were not safe for children under the age of two and older children with chronic illnesses. This meant of the children targeted in the limited vaccine subset, only healthy, children aged two to four could safely receive the available vaccine. The changes in target groups and the initial availability of only LAIV caused confusion within states and localities regarding who should be targeted for vaccination (Hopkins 2011). Vaccination of children was further complicated because children under the age of ten were recommended to receive two doses of the H1N1 influenza vaccine (Centers for Disease Control and Prevention 2010).

While the distribution of H1N1 vaccine differed across states and localities, the CDC reported that most states allocated H1N1 vaccine to the target groups during the shortage (Centers for Disease Control and Prevention 2010; Hopkins 2011). By the end of December, 27.9 percent of the initial target group and 37.5 percent of the limited vaccine subset had been vaccinated compared with 20.3 percent of the general population over the age of six months (Centers for Disease Control and Prevention 2010). During the period of vaccine shortage from October through December, 2009, 29.4 percent of children aged six months to 18 years had received at least one dose of vaccine but only 17.8 percent of children aged six months to ten years had received two doses of vaccine. The current study found that 67.4 percent of healthcare professionals with children in the household were vaccinated for H1N1 influenza in October-December, 2009 compared to 27.5 percent of healthcare professionals without children in the household.

Given the initial shortage of H1N1 vaccine and the recommendation for children under age 10 to receive two doses of vaccine, healthcare professionals with children in the household may have demonstrated increased demand for H1N1 influenza vaccine because they were concerned that the children would not be able to receive the H1N1 influenza. Being vaccinated was then a way for these healthcare professionals to protect themselves and also the children in their homes. This suggests that promoting influenza vaccination and increasing access to influenza vaccines among adults with children in the household may encourage vaccine uptake particularly during times of resource scarcity. The results of the current study does not indicate how we might achieve this, but other research indicates that offering influenza vaccines to parents at pediatricians' offices is one way to increase access among adults with children in the household (Cooper White, Baum et al. 2010; Lessin, Edwards et al. 2012).

In the current study, we were also able to learn from the attitudes held by healthcare professionals about influenza and the influenza vaccine. Healthcare professionals with children in the household were no more likely to agree that vaccines are safe, or to disagree that influenza vaccines cause influenza. Healthcare professionals with children in the household were more likely to agree that both types of influenza (seasonal and H1N1) were serious diseases. Consistent with recommendations from other studies, these findings suggest that emphasis on the seriousness of influenza can lead to increased vaccine uptake (Harris, Maurer et al. 2010).

The current study is limited by being a descriptive study of the 2008-2009 and 2009-2010 influenza seasons. Causality cannot be inferred based on the results from these two cross-sectional surveys. Respondent bias is always a concern with survey data and perhaps more so during the 2009-2010 influenza season due to potential confusion between seasonal and H1N1 influenza. Although rates of vaccination derived from the 2010 RAND Influenza Vaccine Tracking Survey are similar to the rates reported by the CDC (Centers for Disease Control and Prevention 2010). The study is also limited by the timing of the attitude questions, which were assessed at the end of the influenza season. A better understanding of the association between attitudes and influenza vaccination could be gained from assessing attitudes prior to the influenza season and then observing vaccination behavior during that season.

Future research may explore the relationship between other household contracts that are high-priority for influenza vaccination, such as adults over the age of 50, or the number of household contacts to determine the effect these household contacts have on vaccine uptake among health care professionals and the broader population. It would also be interesting to explore individual's perceptions regarding their susceptibility and exposure to influenza, the costs of acquiring influenza, and the risk of infecting household members with influenza.

The results of the current study suggest that public health officials and healthcare professionals should work to encourage influenza vaccine uptake among adults with and without children in the household. The results from the current study suggest that access to influenza vaccination plays a role in vaccine uptake, at least among healthcare professionals with children in the household. Therefore, in considering how to increase influenza vaccine uptake we may consider different strategies for parents and non-parents. As noted earlier, offering influenza vaccination to parents in pediatrician's offices is one way to increase access to influenza vaccination among parents (Lessin, Edwards et al. 2012). Among all adults, other research indicates that receiving a mail, telephone, or email reminder for influenza vaccination and receiving a recommendation from a healthcare provider for influenza vaccination is positively associated with influenza vaccine uptake (see Chapter 4 and Maurer and Harris 2011).

4. Healthcare Provider-Issued Reminders and Recommendations for Influenza Vaccination: Does the Patient's Age Matter?

Introduction

Young and middle-aged adults aged 19 to 49 have lower rates of health insurance coverage and less contact with healthcare professionals compared to older adults (National Center for Health Statistics 2011; National Center for Health Statistics 2012). This may change as a result of the Affordable Care Act (ACA), because the ACA is projected to increase the rate of insurance coverage to over 90 percent among non-elderly adults (Buettgens and Hall 2011). The ACA has already lead to an increase in insurance coverage from 64 percent in September 2010 to 75 percent in December 2011 among adults aged 19 to 25 due to the dependent coverage change which allowed young adults to remain on their parents' health insurance until the age of 26 (Sommers 2012). This ACA provision has also been associated with an increase in having a usual source of care and a decrease in delays in getting care due to cost among adults aged 19 to 25 as assessed between September 2010 to September 2011 (Sommers, Buchmueller et al. 2013).

The increase in rates of insurance coverage and usual source of care that have already resulted among young adults aged 19 to 25 and are projected to result among the broader population of young and middle-aged adults will provide healthcare professionals with more opportunities to recommend preventive health services, such as routine check-ups, breast cancer screenings, and vaccines, to young and middle-aged adults. If the ACA leads to increases in insurance coverage or in having a usual source of care, then healthcare professionals and insurers will have contact information on file for more young and middle-aged adults allowing them to send mail or telephone reminders for preventative health services. If having health insurance coverage leads to more face-to-face contact with healthcare professionals, this will allow for more opportunities for healthcare professionals to provide recommendations for preventative health services. To understand whether increased opportunities to provide reminders and recommendations will actually lead to increased uptake of preventative health services among young and middle-aged adults, we need to understand how young and middle-aged adults respond to reminders and recommendations from healthcare professionals.

Influenza vaccination presents an ideal case from which we can explore this issue because the Center for Disease Control and Prevention's (CDC) Advisory Committee on Immunization Practices (ACIP) currently recommends annual influenza vaccination for all adults (Fiore, Uyeki et al. 2010). This reflects an expansion of the recommendations to include healthy adults aged 19 to 49 as of the 2010-2011 influenza season (Fiore, Uyeki et al. 2010). Research indicates that contact with healthcare professionals has a positive association with influenza vaccine uptake among the broad population of adults aged 18 and older (Maurer and Harris 2011); however, no studies have explored the way this association varies by age. Age is an important factor in the physician-patient relationship. While younger adults report higher levels of trust in physicians than older adults, they are less likely to report the intention to follow physician recommendations and in practice, they are actually less complaint with physician recommendations (Hesse, Nelson et al. 2005; Grandes, Sanchez et al. 2009; Brown, Aitken et al. 2010; Uscher-Pines, Maurer et al. 2010).

The current study assesses how age moderated the association between contact with healthcare providers and influenza vaccine uptake using a nationally representative sample of adults from the 2009-2010 influenza season. The results of the study will determine whether there were similar positive associations between healthcare provider recommendations or reminders and influenza vaccine uptake among adults aged 19 to 49 and adults aged 50 and older. Breaking out the association between influenza vaccine uptake and healthcare provider interactions by age will allow us to speculate on whether the expansion of health insurance coverage among young adults to levels similar to that of older adults through the ACA will have a positive impact on influenza vaccine uptake.

Method

Data

This study used cross-sectional data from a nationally representative survey of adults aged 18 and older designed by the RAND Corporation and conducted by Knowledge Networks (currently known as GfK). The survey has been described in detail elsewhere (Maurer, Uscher-Pines et al. 2010; Maurer and Harris 2011). Briefly, the survey asked questions about the respondents' experience with seasonal and H1N1 influenza vaccines during the 2009-2010 influenza season. The data were collected among a nationally representative online panel of adults aged 18 and older between March 4, 2010 and March 24, 2010. Knowledge Networks composed their panel using a probability sample which captured households with and without internet access (Knowledge Networks 2012). The survey oversampled African Americans, Hispanic Americans, and adults aged 65 and older in order to obtain a distribution of participants that was diverse in terms of age and ethnicity. A total of 5,495 panelists aged 18 and older were invited to participate with 4,040 (73.5%) respondents completing the survey. Among the participants, 1,008 respondents were aged 19 to 49 and 3,024 were aged 50 and older.

Although the data used are limited by being cross-sectional, they are unique in that they capture the influenza season precisely and contain self-report of receipt of reminders and healthcare provider recommendations for influenza vaccination. The data are also limited by being from an influenza season when healthy adults aged 19 to 49 were not recommended for influenza vaccination by the ACIP. This is accounted for in the modeling and the implications of this are discussed further in the Discussion section.

Outcome Variables

There were two vaccination outcomes of interest:

- Self-reported seasonal influenza vaccination during the 2009-2010 influenza season
- Self-reported H1N1 influenza vaccination during the 2009-2010 influenza season

Vaccination status was assessed by the questions "Did you get a seasonal flu vaccine this past flu season (August 2009 to March 2010)?" and "Have you received a H1N1/Swine flu vaccine this flu season?."

Main Covariates of Interest

Receipt of recommendations was assessed by self-report of receiving a recommendation from a healthcare provider. Receipt of reminders was assessed by self-report of receiving a mailed, telephone, email, or text message reminder from a physician, nurse, physician's assistant, other healthcare provider, health insurance, health plan, health department, employer, or drug store. It is important to note that direct contact with a healthcare provider is required to receive a recommendation as defined in this study. This would occur through a doctor's office visit. Reminders, however, can be given to anyone who is on record within a health system, an insurance company, a public health agency, a retail clinic, or an employer.

Reminders to uptake the influenza vaccine were separated into three mutually exclusive groups: reminders for both seasonal and H1N1 influenza, reminder for seasonal influenza only, and reminder for H1N1 influenza only. Healthcare provider issued recommendations to be vaccinated for influenza were also separated into three mutually exclusive groups: recommendations for both seasonal and H1N1 influenza, recommendation for only seasonal influenza, and recommendation for only H1N1 influenza.

Other Covariates

Respondent's ACIP recommendation status was determined for seasonal and H1N1 influenza based on the respondent's self-reported age, high-risk conditions (e.g., asthma), pregnancy, employment as a healthcare worker, close contact with adults aged 50 and older, and close contact with children under the age of 5 (Centers for Disease Control and Prevention 2009; Fiore, Shay et al. 2009). The influenza-type specific ACIP recommended groups were included as individual controls in the regression analyses described in the analysis section in addition to sociodemographic covariates (race, sex, education level, marriage status, household income, health insurance coverage, region of residence, and metro-area residence).

Receiving a recommendation from a provider is different from belonging to a group recommended for influenza vaccination by the ACIP. For example, parents of children under the age of five are recommended to receive influenza vaccination by the ACIP but an individual parent may or may not receive a recommendation from her healthcare provider to be vaccinated.

While adults aged 19 to 24 were recommended for H1N1 influenza vaccination by the ACIP and adults aged 25 to 49 were not, we did not distinguish between adults aged 19 to 24 and adults aged 25 to 49 in the analyses. The ACIP recommendations for H1N1 influenza vaccination stated that in the case of a vaccine shortage, 19 to 24 year olds were not considered a priority group for H1N1 influenza vaccination. There was a shortage of H1N1 influenza vaccine during the 2009-2010 influenza season; therefore, it is likely that most adults and healthcare providers did not consider adults aged 19 to 24 to be a priority group for H1N1 influenza vaccine. This is further supported in the data as there were low rates of healthcare provider-issued reminders and recommendations for H1N1 influenza vaccination among adults aged 19-24.

Analysis

Seasonal influenza and H1N1 influenza vaccination rates were compared for adults aged 19 to 49 and adults aged 50 and older using Wald tests. The rates of doctor's office visits, and the rates reminders and recommendations for seasonal and H1N1 influenza were also compared by age group using Wald tests.

A test of structural change was conducted for each model included in the analysis to determine whether separate models should be run for adults aged 19 to 49 and adults aged 50 and older.

The test for structural change used a Gauss-Newton regression to test the separate model against the pooled model (MacKinnon 1989; Mackinnon 1992). The results indicated that fully-interacted models should be run for seasonal influenza vaccine uptake but that pooled models should be run for H1N1 influenza vaccine uptake. Given the discrepancy, both fully-interacted models (i.e., coefficients on control variables can vary by age group) and pooled models (i.e., coefficients on control variables cannot vary by age group) were run for all analyses described here. The results across both types of models were consistent in terms of direction, magnitude, and significance. For ease of interpretation, all results presented here are from fully interacted models.

To assess the differential impact of healthcare provider-issued reminders for influenza vaccination by age group, bivariate probit models were estimated as described below. Models were also estimated to assess the differential impact of healthcare provider-issued recommendations for influenza vaccination by age group as described below. All models assessing the impact of healthcare provider-issued recommendations for influenza vaccination were conducted among the group of adults who reported attending a doctor's office visit between September 2009 and March 2010. We subset the data to this group because one would have to attend a doctor's visit to receive a recommendation from a healthcare provider. We included doctor's office visits from September 2009 through March 2010 based on the ACIP recommendations for the 2009-2010 influenza season. The ACIP recommended beginning vaccination in September or as early as seasonal influenza vaccine was available and continuing vaccination even after influenza activity has begun in the given area (Fiore, Shay et al. 2009). Influenza activity may occur in some regions as late as February or March in any given season (Fiore, Shay et al. 2009), therefore to be inclusive of the time when influenza vaccination campaigns were occurring we include doctor's office visits from September 2009 to March 2010. The bivariate probit model is:

$$seasonal\ influenza\ vaccination^* = \ age\beta_{1a} + X_1\beta_{1b} + (X_1 * age)\beta_{1c} + \varepsilon_1,$$
$$if\ seasonal\ influenza\ vaccination^* > 0, 0\ otherwise$$

$$H1N1\ influenza\ vaccination^* = \ age\beta_{2a} + X_1\beta_{2b} + (X_1 * age)\beta_{2c} + \varepsilon_2,$$
$$if H1N1\ influenza\ vaccination^* > 0, 0\ otherwise$$

$$E[\varepsilon_1|x_1, x_2] = E[\varepsilon_2|x_1, x_2] = 0$$
$$Var[\varepsilon_1|x_1, x_2] = Var[\varepsilon_2|x_1, x_2] = 1$$
$$Cov[\varepsilon_1, \varepsilon_2|x_1, x_2] = \ \rho$$

Where β_{1a} and β_{2a} represent the coefficients on *age* (indicator for aged 19 to 49); β_{1b} represents a vector of regression coefficients corresponding to the covariates X_1 (which include indicators for receipt of both seasonal and H1N1 influenza vaccine reminders/recommendations, receipt of only seasonal influenza reminders/recommendations, and receipt of only H1N1 reminders/recommendations, race (Black, Hispanic, and other race compared to White), sex, marriage status (married or living with a partner compared to single), education level (some college, college or higher, compared to high school degree or less), household income, health insurance coverage, region of residence (South, Midwest, and West compared to Northeast), metro-area residence, and indicators for groups recommended for seasonal influenza vaccination by the ACIP (described in detail above); β_{1c} represents a vector of coefficients corresponding to the covariates X_1 interacted with the age indicator; β_{2b} represents a vector of regression coefficients corresponding to the covariates X_2 (which includes the same variables as the X_1 vector except indicators for groups recommended for H1N1 influenza vaccination by the ACIP are substituted for the seasonal influenza recommended groups); and β_{2c} represents a vector of regression coefficients corresponding to the covariates X_2 interacted with the age indicator.

All analyses were conducted using STATA/IC 11 (StataCorp, College Station, TX). In order to generate nationally representative estimates, post-stratification weights were used. Standard errors were calculated using a Taylor series linearization method in order to account for potential arbitrary heteroskedasticity in the distribution of the errors. The predicted probabilities of influenza vaccination were calculated using STATA's margins command for every combination of age group and reminder or recommendation (i.e., receipt of both seasonal and H1N1 influenza vaccination reminders/recommendations, receipt of only seasonal influenza vaccination reminder/recommendation, and receipt of only H1N1 influenza vaccination reminder/recommendation). All other control variables were left as observed for each respondent (for more detail on this method see (Setodji, Scheuner et al. 2012)).

Results

During the 2009-2010 influenza season, significantly more adults aged 50 and older were vaccinated for seasonal influenza than adults aged 19 to 49 (52.51% vs. 29.52%, $p<0.05$; see Table 7). The same pattern held for H1N1 influenza vaccination (22.57% vs. 17.78%, $p<0.05$). There was no significant difference in the percent of adults who received any reminder for influenza vaccination (both seasonal and H1N1 influenza vaccination reminders, only seasonal influenza vaccination reminder, or only H1N1 influenza vaccination reminder) between adults aged 19 to 49 and adults aged 50 and older (28.11% vs. 32.07%; see Table 8). Significantly fewer adults aged 19 to 49 attended a doctor's office visit between September 2009 and March 2010 than adults aged 50 and older (58.80% vs. 77.55%, $p\leq0.05$). Among adults who did attend a doctor's office visit during this time, significantly fewer adults aged 19 to 49 received a recommendation for any type of influenza vaccination than adults aged 50 and older (36.54% vs. 55.87%, $p\leq0.05$).

Reminders for Influenza Vaccination
Receipt of reminders for influenza vaccination was significantly associated with influenza vaccine uptake among adults aged 19 to 49 and among adults aged 50 and older (see Figures 6-8, and Table 9). In general, the magnitude of the association between reminders and influenza vaccine uptake did not differ between adults aged 19 to 49 and adults aged 50 and older. This indicates that the association between reminders and influenza vaccine uptake was not stronger for one age group compared to the other.

Receipt of reminders for both seasonal and H1N1 influenza vaccination was positively associated with uptake of both types of vaccination among adults aged 19 to 49 and adults aged 50 and older (see Figure 6). Specifically, receipt of both seasonal and H1N1 influenza vaccination reminders was associated with a significant increase in the probability of being vaccinated for both seasonal and H1N1 influenza from 11.09 percent to 24.91 percent among adults aged 19 to 49 and from 15.03 percent to 33.98 percent among adults aged 50 and older ($p \leq 0.05$).

As shown in Figure 7, receiving reminders for only seasonal influenza vaccination was positively associated with uptake of seasonal influenza vaccination among adults aged 19 to 49 and adults aged 50 and older. Receipt of reminders for only seasonal influenza vaccination was associated with a significant increase in the probability of being vaccinated for only seasonal influenza from 14.14 percent to 32.71 percent among adults aged 19 to 49 and from 27.09 percent to 55.90 percent among adults aged 50 and older ($p \leq 0.05$).

Finally, Figure 8 shows that receipt of reminders for only H1N1 influenza vaccination was positively associated with H1N1 influenza vaccination among adults aged 50 and older but not among adults aged 19 to 49. The receipt of reminders for only H1N1 influenza vaccination was associated with an increase in the probability of being vaccinated for only H1N1 influenza from 2.37 percent to 9.08 percent among adults aged 50 and older ($p \leq 0.05$).

Health Care Provider-Issued Recommendations for Influenza Vaccination

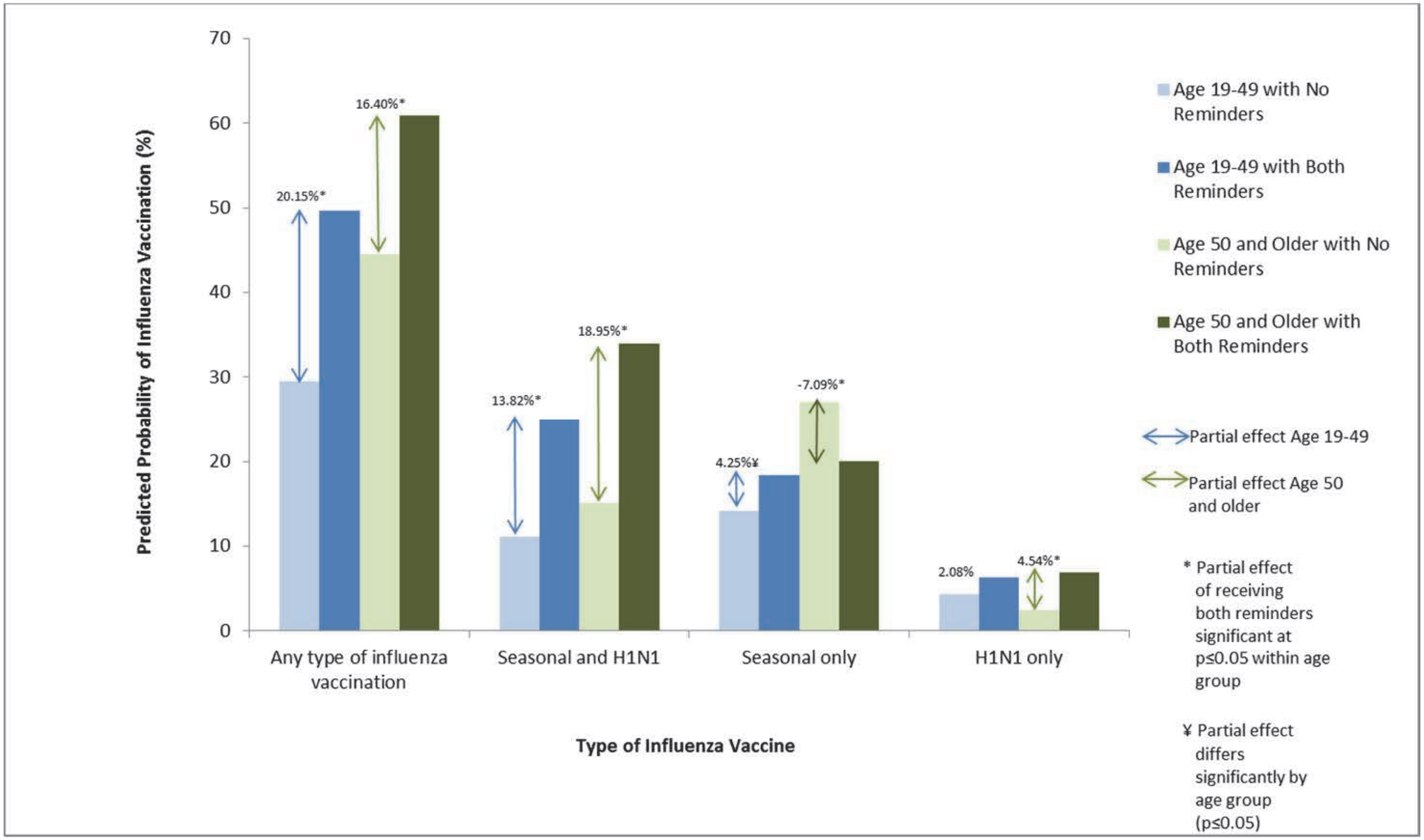
Among adults who attended a doctor's office visit between September 2009 and March 2010, receipt of recommendations for influenza from a healthcare provider was associated with an increase in the probability of influenza vaccination (see Figures 9-11, and Table 10). In most cases, the magnitude of the association between recommendations and influenza vaccine uptake did not differ between adults aged 19 to 49 and adults aged 50 and older. Receipt of reminders for only seasonal influenza did have a stronger association with uptake of any type of influenza vaccination and with uptake of only seasonal influenza vaccination among adults aged 50 and older compared to adults aged 19 to 49 (for details see Table 10 and Figure 10).

Figure 9 shows that receipt of recommendations for both seasonal and H1N1 influenza vaccination was positively associated with uptake of both seasonal and H1N1 influenza vaccines among adults aged 19 to 49 and adults aged 50 and older. Receipt of recommendations for both seasonal and H1N1 influenza was associated with an increase in the probability of being vaccinated for both seasonal and H1N1 influenza from 8.96 percent to 45.48 percent among adults aged 19 to 49 who attended a doctor's visit between September 2009 and March 2010 and from 10.49 percent to 46.74 percent among adults aged 50 and older who attended a doctor's visit between September 2009 and March 2010 ($p \leq 0.05$).

As shown in Figure 10 receipt of a healthcare provider-issued recommendation for only seasonal influenza was positively associated with seasonal influenza vaccination among adults aged 19 to 49 and adults aged 50 and older. Receipt of a recommendation for only seasonal influenza vaccination was associated with an increase in the probability of being vaccinated for only seasonal influenza from 17.29 percent to 47.05 percent among adults aged 19 to 49 who attended a doctor's office visit from September 2009 to March 2010 and from 22.41 percent to 72.30 percent among adults aged 50 and older who attended a doctor's office visit from September 2009 to March 2010 ($p \leq 0.05$). The magnitude of the increase in influenza vaccine uptake among those who received a recommendation for only seasonal influenza compared to those who received no recommendations was greater among adults aged 50 and older than among adults aged 19 to 49 (49.89 percentage point increase versus 29.76 percentage point increase, $p \leq 0.05$).

Finally, Figure 11 shows that receipt of a healthcare provider-issued recommendation for only H1N1 influenza vaccination was positively associated with uptake of H1N1 influenza vaccination among adults aged 19 to 49 but not among adults aged 50 and older. Receipt of recommendations for only H1N1 influenza vaccination was associated with an increase in the probability of being vaccinated for only H1N1 influenza from 2.94 percent to 38.17 percent among adults aged 19 to 49 who attended a doctor's office visit from September 2009 to March 2010 ($p \leq 0.05$). Receipt of a recommendation for only H1N1 influenza vaccination was also positively associated with uptake of both seasonal and H1N1 influenza vaccinations among adults aged 19 to 49 from 8.96 percent to 40.65 percent and among adults aged 50 and older from 10.49 percent to 44.46 percent among those who attended a doctor's office visit between September 2009 and March 2010 ($p \leq 0.05$).

Figure 6. Predicted Probabilities of Influenza Vaccination among Adults aged 19-49 and Adults aged 50 and Older by Receipt of Both Seasonal and H1N1 Influenza Vaccine Reminders†‡§

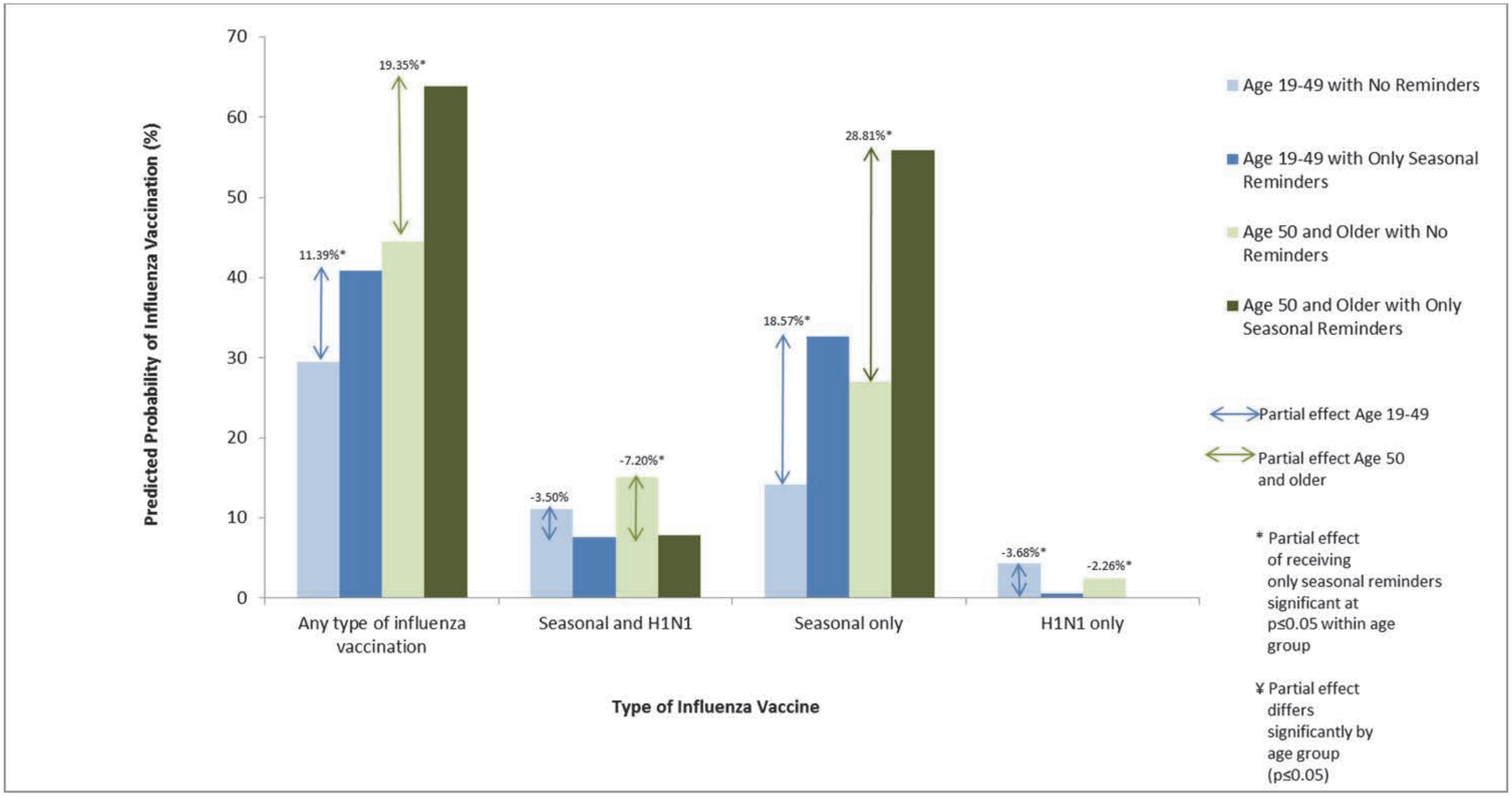


† Predicted probability from bivariate probit models for influenza vaccine uptake adjusted for sex, race, education, marriage status, income, employment status region of residence, urban residence, and influenza-type specific ACIP recommendations

‡ The sample size was 3,633

§ All estimates weighted to be nationally representative using data from the Current Population Survey

Figure 7. Predicted Probabilities of Influenza Vaccination among Adults aged 19-49 and Adults aged 50 and Older by Receipt of Only Seasonal Influenza Vaccine Reminders†‡§

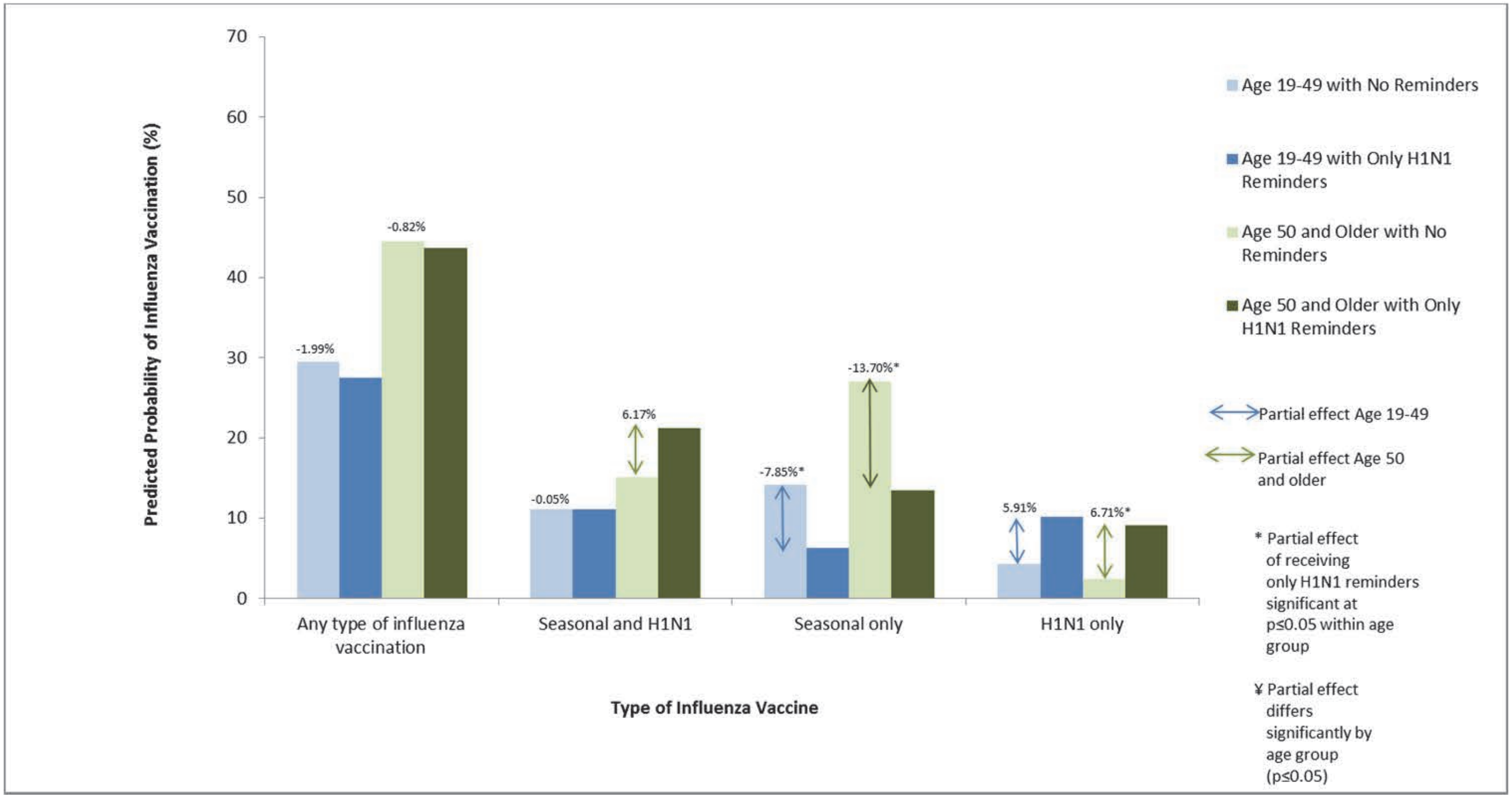


† Predicted probability from bivariate probit models for influenza vaccine uptake adjusted for sex, race, education, marriage status, income, employment status region of residence, urban residence, and influenza-type specific ACIP recommendations

‡ The sample size was 3,633

§ All estimates weighted to be nationally representative using data from the Current Population Survey

Figure 8. Predicted Probabilities of Influenza Vaccination among Adults aged 19-49 and Adults aged 50 and Older by Receipt of Only H1N1 Influenza Vaccine Reminders†‡§

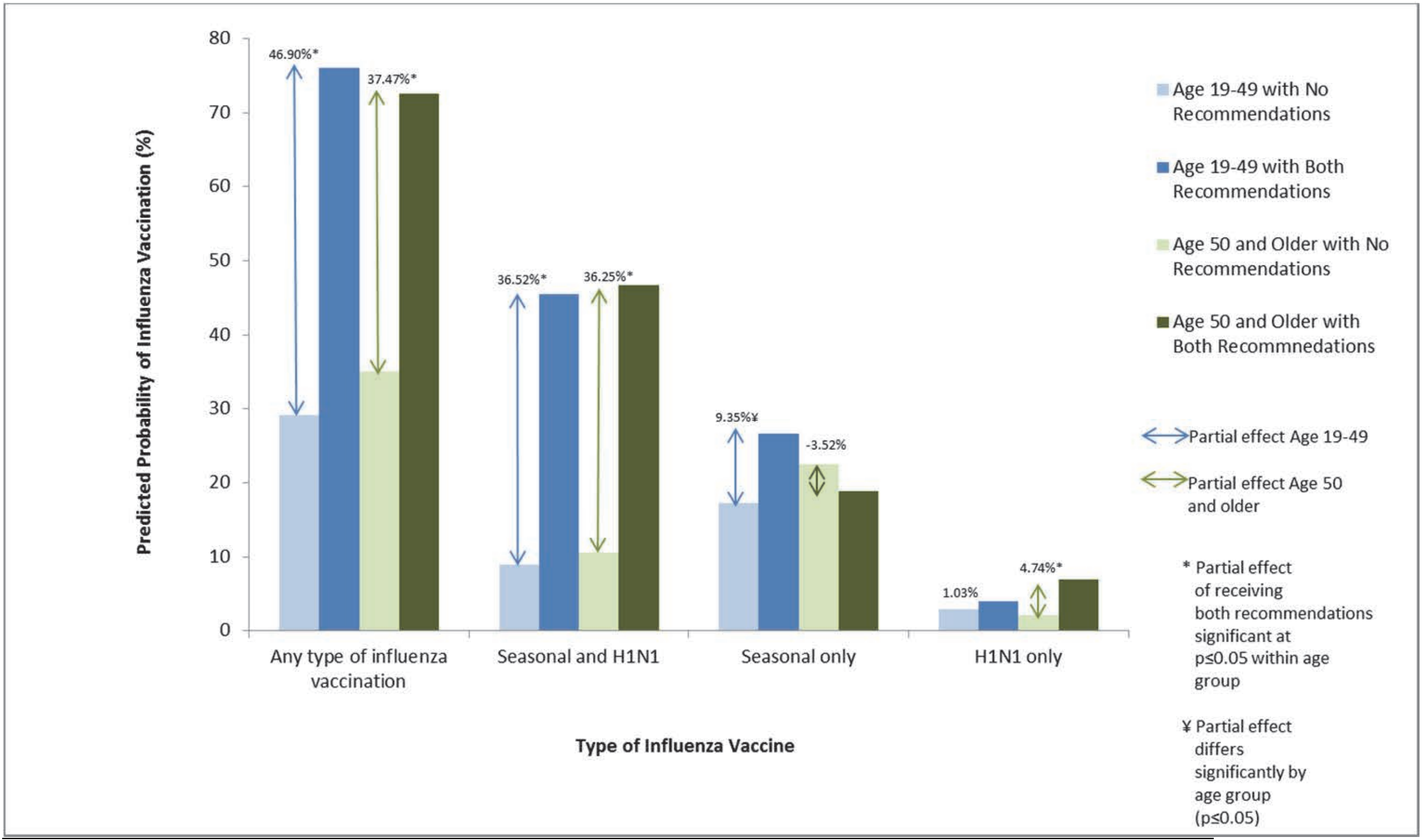


† Predicted probability from bivariate probit models for influenza vaccine uptake adjusted for sex, race, education, marriage status, income, employment status region of residence, urban residence, and influenza-type specific ACIP recommendations

‡ The sample size was 3,633

§ All estimates weighted to be nationally representative using data from the Current Population Survey

Figure 9. Predicted Probabilities of Influenza Vaccination among Adults aged 19-49 and Adults aged 50 and Older by Receipt of Both Seasonal and H1N1 Influenza Vaccine Recommendations†‡§

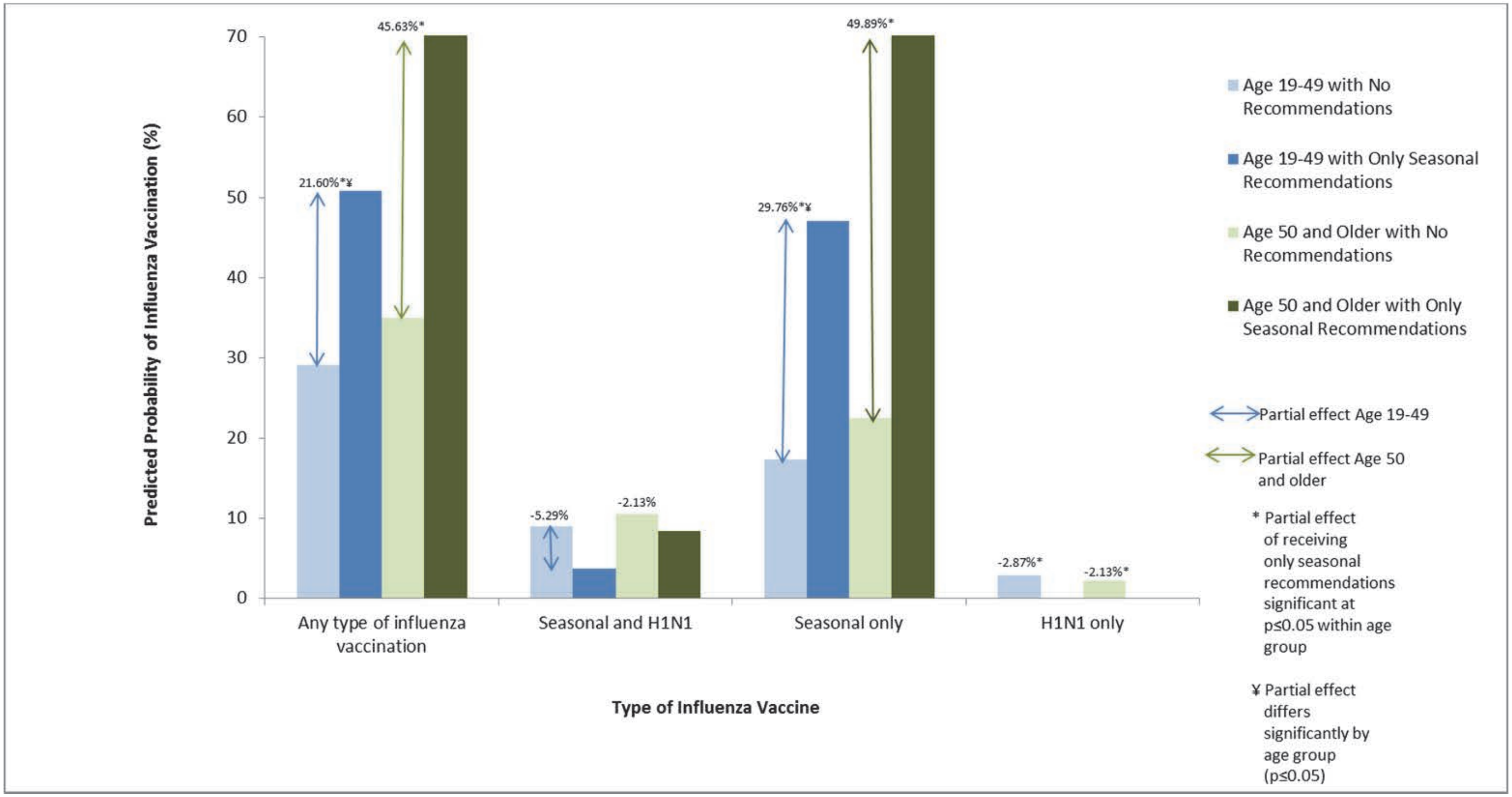


† Predicted probability from bivariate probit models for influenza vaccine uptake adjusted for sex, race, education, marriage status, income, employment status region of residence, urban residence, and influenza-type specific ACIP recommendations conditional on attending a doctor's office visit between September 2009 and March 2010.

‡ The sample size was 2,687

§ All estimates weighted to be nationally representative using data from the Current Population Survey

Figure 10. Predicted Probabilities of Influenza Vaccination among Adults aged 19-49 and Adults aged 50 and Older by Receipt of Only Seasonal Influenza Vaccine Recommendations†‡§

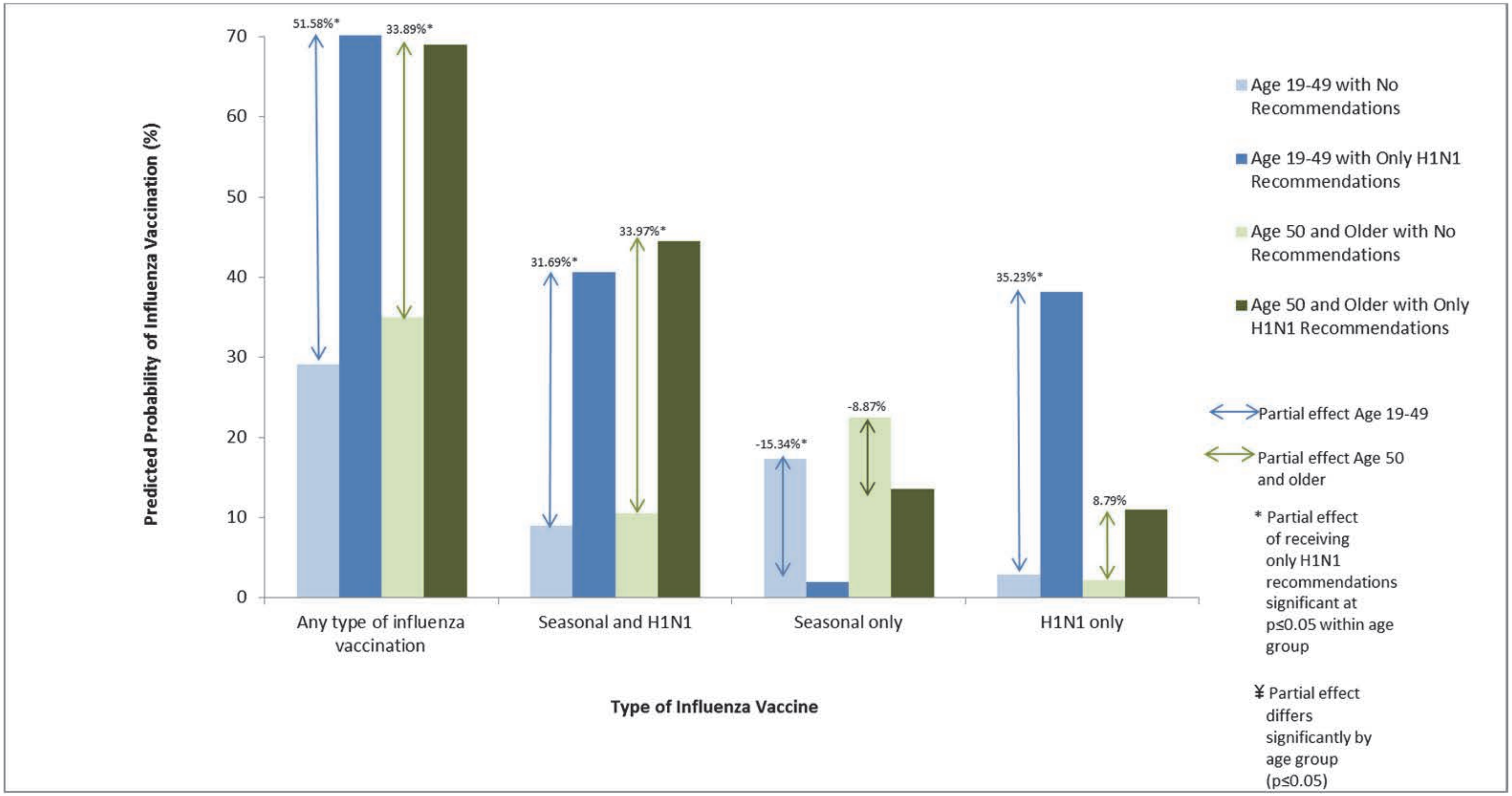


† Predicted probability from bivariate probit models for influenza vaccine uptake adjusted for sex, race, education, marriage status, income, employment status region of residence, urban residence, and influenza-type specific ACIP recommendations conditional on attending a doctor's office visit between September 2009 and March 2010.

‡ The sample size was 2,687

§ All estimates weighted to be nationally representative using data from the Current Population Survey

Figure 11. Predicted Probabilities of Influenza Vaccination among Adults aged 19-49 and Adults aged 50 and Older by Receipt of Only H1N1 Influenza Vaccine Recommendations†‡§



† Predicted probability from bivariate probit models for influenza vaccine uptake adjusted for sex, race, education, marriage status, income, employment status region of residence, urban residence, and influenza-type specific ACIP recommendations conditional on attending a doctor's office visit between September 2009 and March 2010.

‡ The sample size was 2,687

§ All estimates weighted to be nationally representative using data from the Current Population Survey

Table 7. Influenza Vaccination Rates among Adults by Age Group during the 2009-2010 Influenza Season†

	Received Seasonal Influenza Vaccine‡		Received H1N1 Influenza Vaccine‡	
	n§	% (95% CI)	n§	% (95% CI)
Adults Aged 19-49	1,006	29.52 (25.50, 33.54)	1,000	17.78 (14.47, 21.08)
All Adults Aged 50 and older	3,020	52.51 (49.71, 55.31)	3,019	22.57 (20.21, 24.93)

† All estimates weighted to be nationally representative using data from the Current Population Survey
‡ Difference between adults aged 19-49 and adults aged 50 and older is significant ($p \leq 0.05$)
§ Throughout, differences in sample sizes across models are the result of missing observations for one or more variables used in the model.

Table 8. Rates of Reminders, Doctor's Office Visits, and Recommendations by Age Group during the 2009-2010 Influenza Season†

	Adults aged 19 to 49		Adults aged 50 and Older	
	n§	% (95% CI)	n§	% (95% CI)
Received a reminder for				
Any type of influenza vaccination	939	28.11 (24.07, 32.15)	2,767	32.07 (29.36, 34.77)
Both seasonal and H1N1 influenza vaccination		20.18 (16.55, 23.81)		20.40 (18.11, 22.69)
Only seasonal influenza vaccination‡		4.88 (2.90, 6.85)		9.56 (7.80, 11.33)
Only H1N1 influenza vaccination		3.05 (1.73, 4.38)		2.10 (1.31, 2.90)
Attended a doctor's office visit between September 2009 and March 2010‡	996	58.80 (54.44, 63.16)	3,013	77.55 (75.17, 79.93)
Received a recommendation for				
Any type of influenza vaccination‡	558	36.54 (31.08, 42.01)	2,211	55.87 (52.66, 59.08)
Both seasonal and H1N1 influenza vaccination		24.26 (19.49, 29.04)		29.31 (26.41, 32.20)
Only seasonal influenza vaccination‡		8.78 (5.72, 11.83)		25.00 (22.18, 27.83)
Only H1N1 influenza vaccination		3.51 (1.23, 5.78)		1.56 (0.85, 2.26)

† All estimates weighted to be nationally representative using data from the Current Population Survey

‡ Difference between adults aged 19-49 and adults aged 50 and older is significant ($p \leq 0.05$)

§ Throughout, differences in sample sizes across models are the result of missing observations for one or more variables used in the model.

Table 9. Predicted Probabilities of Influenza Vaccination between Adults aged 19-49 and Adults aged 50 and Older by Receipt of Reminders for Influenza Vaccination†‡

	Any type of influenza vaccination		Association with detailed vaccination patterns					
			Seasonal and H1N1		Seasonal only		H1N1 only	
	Predicted probability§* (95%-CI)		Predicted probability§* (95%-CI)		Predicted probability§* (95%-CI)		Predicted probability§* (95%-CI)	
Did not receive a reminder to get vaccinated								
Age 19-49	29.47	(24.42, 34.53)	11.09	(7.99, 14.19)	14.14	(10.50, 17.78)	4.24	(2.72, 5.76)
Age 50 and older	44.49	(40.50, 48.48)	15.03	(12.59, 17.47)	27.09	(23.55, 30.64)	2.37	(1.30, 3.44)
Received a reminder to get vaccinated for Both seasonal and H1N1								
Age 19-49	49.62	(39.96, 59.28)	24.91	(17.05, 32.77)	18.39	(11.51, 25.26)	6.32	(2.43, 10.21)
Age 50 and older	60.89	(54.89, 66.89)	33.98	(28.24, 39.72)	20.00	(15.82, 24.19)	6.91	(4.39, 9.43)
Seasonal only								
Age 19-49	40.86	(22.44, 59.27)	7.59	(1.91, 13.28)	32.71	(14.81, 50.61)	0.56	(-0.45, 1.56)
Age 50 and older	63.84	(54.63, 73.06)	7.83	(3.41, 12.26)	55.90	(46.49, 65.31)	0.11	(-0.08, 0.29)
H1N1 only								
Age 19-49	27.48	(8.80, 46.17)	11.04	(4.07, 21.68)	6.29	(-0.41, 12.98)	10.15	(0.29, 20.02)
Age 50 and older	43.67	(26.96, 60.37)	21.20	(8.67, 33.73)	13.39	(7.66, 19.12)	9.08	(3.83, 14.32)

† Predicted probability from a bivariate probit model for influenza vaccine uptake adjusted for sex, race, education, marriage status, income, employment status region of residence, urban residence, and influenza-type specific ACIP recommendations

‡ The sample size was 3,633

§ All estimates weighted to be nationally representative using data from the Current Population Survey

* $p \leq 0.05$

Table 10. Predicted Probabilities of Influenza Vaccination between Adults aged 19-49 and Adults aged 50 and Older by Receipt of Recommendations for Influenza Vaccination†‡

	Any type of influenza vaccination		Association with detailed vaccination patterns					
			Seasonal and H1N1		Seasonal only		H1N1 only	
	Predicted probability§* (95%-CI)		Predicted probability§* (95%-CI)		Predicted probability§* (95%-CI)		Predicted probability§* (95%-CI)	
Did not receive a recommendation to get vaccinated								
Age 19-49	29.19	(21.73, 36.65)	8.96	(5.03, 12.88)	17.29	(11.47, 23.11)	2.94	(1.35, 4.53)
Age 50 and older	35.05	(30.23, 39.86)	10.49	(7.78, 13.20)	22.41	(18.11, 26.71)	2.15	(0.88, 3.41)
Received a recommendation to get vaccinated for Both seasonal and H1N1								
Age 19-49	76.09	(67.44, 84.72)	45.48	(34.81, 56.14)	26.64	(17.58, 35.70)	3.97	(1.09, 6.84)
Age 50 and older	72.52	(66.76, 78.27)	46.74	(40.35, 53.13)	18.89	(13.98, 23.81)	6.89	(4.09, 9.69)
Seasonal only								
Age 19-49	50.79	(33.55, 68.02)	3.67	(-1.18, 8.51)	47.05	(30.16, 63.94)	0.07	(-0.14, 0.27)
Age 50 and older	80.68	(74.45, 86.88)	8.36	(4.34, 12.37)	72.30	(64.70, 79.89)	0.02	(-0.02, 0.05)
H1N1 only								
Age 19-49	80.77	(62.86, 98.67)	40.65	(11.56, 69.73)	1.95	(-1.81, 5.71)	38.17	(12.65, 63.69)
Age 50 and older	68.94	(51.04, 86.84)	44.46	(24.61, 64.31)	13.54	(1.07, 26.01)	10.94	(-0.09, 21.98)

† Predicted probability from bivariate probit model for influenza vaccine uptake adjusted for sex, race, education, marriage status, income, employment status region of residence, urban residence, and influenza-type specific ACIP recommendations

‡ The sample size was 2,687

§ All estimates weighted to be nationally representative using data from the Current Population Survey

* p ≤ 0.05

Discussion

In general, reminders were associated with positive increases in the probability of influenza vaccination among adults aged 19 to 49 and among adults aged 50 and older; however only 28 percent of adults aged 19 to 49 and only 32 percent of adults aged 50 and older received a reminder for any type of influenza vaccination. If the ACA does result in the projected increase in the number of adults with a usual source of healthcare, there will be more opportunities to provide reminders to adults of all ages. These results suggest physicians should provide reminders for influenza vaccination to all of their adult patients. The reminders assessed in this study came from several sources including healthcare providers, drug stores, employers, insurance companies, and public health departments. The burden of sending reminders, therefore, falls not just on physicians but also on public health agencies, retail clinics, and employers.

Reminders can be sent through a variety of delivery methods, including mailed letters or postcards, automated phone messages, email messages, and text messages. The type of delivery mechanism may have an impact on the effectiveness of the reminder and the effectiveness of a given delivery method may vary by age. A review of the effectiveness of physician reminders on vaccinations found that while all reminders had a positive effect on vaccine uptake, telephone reminders were more effective than mailed reminders (Szilagyi, Bordley et al. 2000). This study did not assess email or text message reminders, which may be more effective among younger adults. In the United States, 95% of adults aged 18 to 29 and 85 percent of adults aged 30 to 49 use text messaging on their cell phones compared to only 58% of adults aged 50 to 64 and 24 percent of adults aged 65 and older (Smith 2011). This suggests that text message reminders may be more appropriate for young and middle-aged adults while mailed or automated phone reminders may be more effective among older adults. More research is needed to understand how the delivery mechanism impacts the effectiveness of physician reminders by age group.

Recommendations for influenza vaccination were also associated with increases in the probability of influenza vaccination among adults aged 19 to 49 and among adults aged 50 and older who attended a doctor's office visit from September 2009 through March 2010. It is important to note that only 54 percent of adults aged 19 to 49 attended a doctor's office visit during this time compared to 73 percent of adults aged 50 and older. This indicates that adults aged 19 to 49 had fewer opportunities to receive a healthcare provider recommendation for influenza. Even among those who did attend a doctor's office visit from September 2009 to March 2010, only 37 percent of adults aged 19 to 49 received a recommendation for any type of influenza vaccination compared to 56 percent of adults aged 50 and older. It may be that the number of adults aged 19 to 49 who received recommendations increased somewhat with the expansion of the ACIP recommendations for influenza vaccination to all adults as of the 2010-2011 influenza season; however, it seems likely that many adults aged 19 to 49 are still not receiving recommendations for influenza vaccination when they attend a doctor's office visit. The results of the current study indicate that healthcare providers should consistently provide recommendations for influenza vaccination to their adult patients across all age groups.

The current study is limited by being a descriptive study of the 2009-2010 influenza season; therefore, causality cannot be inferred based on the results. Respondent bias is always a concern with survey data and perhaps more so during the 2009-2010 influenza season due to potential confusion between seasonal and H1N1 influenza. Although, rates of vaccination derived from the survey data used for the current study are very similar to the rates reported by the CDC (Centers for Disease Control and Prevention 2010).

Reminders and recommendations for influenza vaccination are promising ways to encourage influenza vaccination among adults aged 19 to 49 and adults aged 50 and older. The ACA is projected to increase the rates of insurance coverage and usual source of care among adults aged 19 to 49 which will provide physician's offices and insurance companies with contact information for more adults allowing for more reminders to be sent. At the same time, physician's office and insurance companies will need to consider whether they have the resources available to invest in the staffing and infrastructure necessary to send mail, email, text message, or phone reminders. Large health systems, insurance companies, and employers may be in a better position to provide reminders to their adults because it is likely that these organizations already communicate with patients regularly via mail, email, or automated phone messages. With respect to recommendations, healthcare providers can consistently recommend influenza vaccination to their adult patients with little resource investment. The challenge here is in getting young and middle aged adults to have face to face contact with their healthcare providers. It is not clear that the ACA's impact on insurance coverage and usual source of care will lead to increased doctor's office visits. Adults may also be reached by healthcare providers working at retail clinics. Future research should consider the effectiveness of recommendations from pharmacists, nurses, or other staff at retail clinics offering influenza vaccinations.

While there are challenges to providing all adults with reminders and recommendations for influenza vaccination, these strategies were positively associated with influenza vaccine uptake among adults aged 19 to 49 and adults aged 50 and older. These results suggest that it is worthwhile to provide reminders and recommendations to more adults.

5. Influenza Vaccine Knowledge and Attitudes among Adults who have Close, Daily Contact with Children Outside of the Home

Introduction

Childcare workers and other adults who care for young children outside of the home can protect themselves and the children for whom they care by being vaccinated for influenza. Influenza differentially impacts children, resulting in more hospitalizations and deaths among children than any other vaccine-preventable disease (Grijalva, Weinberg et al. 2007; Xu, Kochanek et al. 2010). At the same time adults who care for young children are at risk for acquiring influenza because children are vectors for influenza transmission (Taber, Paredes et al. 1981; Viboud, Boelle et al. 2004). The Center for Disease Control and Prevention's (CDC) Advisory Committee on Immunization Practices (ACIP) recognizes the importance of influenza vaccination among childcare workers by identifying outside of household caregivers of children under the age of five years as a priority group for influenza vaccination (Fiore, Uyeki et al. 2010).

Despite the relevance of influenza transmission to outside of home childcare, influenza vaccine uptake has not been widely explored among childcare workers. Only a handful of studies have assessed influenza vaccine uptake among childcare workers; although, all studies were conducted at a local level (Hayney and Bartell 2005; Lee, Thompson et al. 2008; de Perio, Wiegand et al. 2012). These studies found suboptimal rates of seasonal influenza vaccine uptake among childcare providers (22% - 60%, depending on the influenza season and location).

To gain insight into the influenza vaccine decision among childcare providers, de Perio et al. (2012) also assessed attitudes about influenza vaccination among childcare providers in Ohio. They found that the childcare providers surveyed held positive attitudes about influenza vaccination with the majority agreeing that influenza vaccination was beneficial and that influenza is a serious disease; however, the majority of respondents also felt the influenza vaccine could make them sick (de Perio, Wiegand et al. 2012). These results raise questions as to whether childcare providers' beliefs about influenza vaccination causing illness prevent them from being vaccinated, or whether their beliefs that influenza vaccination is beneficial are sufficient to lead them to be vaccinated, or whether neither of these factors drives their vaccine decision.

In the current study, we assessed attitudes and beliefs about influenza and influenza vaccination through focus groups conducted with childcare providers in Santa Monica, CA at the beginning of the 2013-2014 influenza season. We then compared the focus group findings to results from a nationally representative survey by assessing influenza vaccine uptake, and knowledge and attitudes about influenza and vaccination, among adults who cared for children outside of the home during the 2009-2010 influenza season. This is the first study to the author's knowledge that explores influenza vaccine uptake and attitudes about influenza vaccination among outside of home caregivers of young children at a national level. The survey data also allowed for exploration of both seasonal and H1N1 influenza vaccine uptake among individuals who have close contact with children outside of the home during a pandemic influenza season.

Methods

Focus Groups

Three focus groups were conducted with an average of ten participants per group, for a total of 31 participants. Groups were recruited at an educational workshop for childcare providers held at a non-profit organization that connects families to childcare in Santa Monica, CA. One focus group was conducted in Spanish to accommodate Spanish-speaking childcare providers. Thirty (97%) of the participants were female, 19 (61%) were Hispanic, 5 (16%) were White, 4 (13%) were Black, 2 (6%) were Asian, and 1 (3%) was Middle-Eastern.

Protocol

Based on literature review, key questions were developed. Participants were asked to discuss their day-to-day concerns as a childcare provider, their feelings towards vaccination in general and influenza vaccination specifically, their experience with parents and influenza vaccination, their concerns about getting sick themselves and passing illness on to their family, and their feelings about what might make it easier for them to get the influenza vaccine. The focus groups were audio-recorded and the recordings were transcribed word for word. The Spanish language focus group transcript was translated into English. The focus groups were determined to be exempt from review by the RAND Institutional Review Board because no identifying information about participants other than first name and observed race was recorded.

Analysis

The focus group data were analyzed following the method outlined by Krueger (Krueger 1994). Categories and themes were identified for two of the three focus groups. Then, the third focus group was coded (coding categories available on request from the author). No new themes emerged from the third focus group that were not present in the other two focus groups. This indicated that saturation was achieved with the three focus groups and additional focus groups were not necessary (Morgan 1997).

Survey

Data

This study used cross-sectional data from a nationally representative survey of adults conducted by Knowledge Networks (currently known as GfK) in 2010. The survey has been described in detail elsewhere (Maurer, Uscher-Pines et al. 2010; Maurer and Harris 2011). Briefly, the survey asked questions about the respondents' experience with and attitudes toward seasonal and H1N1 influenza vaccines during the 2009-2010 influenza season. The data were collected among a nationally representative online panel of adults aged 18 and older between March 4, 2010 and March 24, 2010. Knowledge Networks composed their panel using a probability sample which captured households with and without internet access (Knowledge Networks 2012). The RAND survey oversampled African Americans, Hispanic Americans, and adults aged 65 and older in order to obtain a distribution of participants that was diverse in terms of age and ethnicity. A total of 5,495 panelists aged 18 and older were invited to participate with 4,040 (73.5%) respondents completing the survey.

Sample Population

Adults employed as outside of the home care providers of children under age 5 were identified on the following basis:

- Respondents who reported close daily contact with children under the age of five as assessed by the questions "During your normal days, do you have close contact with children under the age of 5?" and "During your normal days, do you have close contact with infants under the age of 6 months?"
- Respondents who were currently employed
- Respondents who reported no children under the age of 5 in the household
- Respondents who were not healthcare professionals or training to be healthcare professionals as assessed by the question "Are you a health-care professional or currently training for a health-care profession?"
- Respondents who did not work or volunteer in a healthcare setting as assessed by the questions "Do you have face-to-face or hands-on contact with outpatients, hospital patients or nursing home residents as a routine part of your paid or volunteer work?" and "Do you provide face-to-face or hands-on care to a seriously ill person at home or as part of your paid or volunteer work?"

This identified employed adults who had close, daily contact with children outside of the home in a non-healthcare setting. This would include childcare workers, childcare center directors, preschool teachers, nannies, and others who care for young children outside of the home. Hereafter this group is referred to as outside of home childcare providers. The data did not allow for identification of adults with children in the home who are also childcare providers; therefore, this sample includes only those adults who have close contact with children outside of the home and do not have children in the household. We specifically excluded those interacting with children in a healthcare setting as their attitudes about the influenza vaccine are likely to differ as a result of their employment and education on health issues. We also specifically excluded non-employed individuals who had close contact with children outside of the home to exclude the group of extended family (e.g., grandparents) who care for young children.

Analysis

All analyses were conducted on the group of outside of home childcare providers and on the group of employed adults not identified as outside of home childcare providers to determine whether outside of home childcare providers differed from other employed adults who do not have close contact with children through their jobs.

Seasonal and H1N1 influenza vaccine uptake were determined by the questions:

- "Did you get a seasonal flu vaccine this past flu season (August 2009 to March 2010)?"
- "Have you received a H1N1/Swine flu vaccine this flu season?"

Attitudes toward influenza and vaccination were assessed by the statements:

- "Flu vaccines cause people to get the flu."
- "In general, vaccines are safe."
- "Seasonal (H1N1/swine) flu is a serious disease."

- "Being vaccinated against seasonal (H1N1/swine) flu is safe,"
- "Seasonal (H1N1/swine) flu vaccination is worth the time and expense."

For all statements, respondents indicated agreement on a 5-point Likert scale that ranged from strongly agree to strongly disagree.

Receptivity to healthcare provider issued recommendations for influenza vaccination were assessed by the questions:

- "Would you get a seasonal flu vaccine if a doctor or health care provider strongly recommended it to you?"
- "Would you get a H1N1/Swine flu vaccine if a doctor or health care provider strongly recommended it to you?"

These questions were only asked among respondents who were not vaccinated for the given type of influenza. All analyses were conducted using STATA/IC 11 (StataCorp, College Station, TX).

Results

Nine themes emerged from the focus groups. These themes can be grouped into four domains: (1) Concern over oneself or one's family becoming ill, (2) support for or against influenza vaccination, (3) barriers to influenza vaccination, and (4) facilitators of influenza vaccination. For each theme, the focus group results are presented first followed by survey results where applicable. Not all themes that emerged from the focus groups have survey results related to them because the survey did not ask questions applicable to each domain.

<u>Concern over Oneself or One's Family Becoming Ill</u>

Childcare providers need to stay healthy
Several participants voiced concerns over catching illness from the children for whom they care. This was particularly concerning to the childcare providers because they did not feel they could take sick days and would have to work even when sick.

> "I think that most of us or a lot of us can't afford to get sick either. You need to take care of yourself. If you come down with the flu you don't have anyone to substitute you."
>
> "Sometimes there is no one to take our place. So, a lot of us work sick which is not good for the kids."
>
> "If I'm not healthy, I won't be able to do the work the children need."

Concern that one's family will get sick
There was concern among the participants about spreading illness to their family, particularly among the childcare providers who have day care centers attached to their homes.

> "I'm more worried with my family because they always get sick. When the babies get sick with the flu or something, my husband and daughter always get sick. I don't know why."

> "I do make sure that my own kids stay away from the day care area, if I know a virus is going around."

<u>Support For or Against Influenza Vaccination</u>

Strong views against influenza vaccination for oneself
Among the childcare providers, there were mixed feelings regarding support for influenza vaccination. The childcare providers who did not believe in influenza vaccination for themselves were often strong and adamant in their stance against influenza vaccination.

> "No way, I never get that (referring to the influenza vaccine)."

> "No, I won't get that vaccine. Never ever."

> "If [the flu] is epidemic, I'll die because I won't be vaccinated."

Consistent with the findings of the focus groups, the survey data also indicated mixed results for seasonal influenza vaccine uptake among outside of home childcare providers with approximately half of childcare providers being vaccinated for seasonal influenza. Although, more outside of home childcare providers were vaccinated for seasonal influenza (48.6% versus 31.8%, $p \leq 0.05$; see Table 11) and H1N1 influenza (28.5% versus 17.8%) than other employed adults.

Support for influenza vaccination of special groups
The childcare providers who did support influenza vaccination for themselves often cited an additional reason for taking up the vaccine beyond their work as a childcare provider, such as asthma or other medical conditions.   There was also support from other childcare providers for influenza vaccination among special groups who they felt needed the vaccine, such as older adults.

> "I have recently been diagnosed with a muscle disease and so they've been giving me a lot of medications and my immune system is down now. So, I have to be extra careful. I'll definitely be getting my [flu] shot."

> "Especially in the elderly they have to really vaccinate because when there is a [flu] virus, it could be another infection like bacteria, especially pneumonia. [The flu] virus opens the door for bacteria infection."

> "[The flu vaccine] really protects kids with asthma."

Barriers to Influenza Vaccination

Misperceptions about influenza vaccines
Misperceptions about the influenza vaccine are a barrier to influenza vaccination with the most commonly discussed misperception being that the influenza vaccine causes influenza. Several of the childcare providers cited personal experience with becoming sick after they were vaccinated for influenza or with seeing others become sick after being vaccinated.

> "When I got the flu vaccine, I got the flu…I spent 15 days being sick."
>
> "I remember I [was] sick one time, very, very sick, a few years ago after I had the flu shot."
>
> "The kids that get [the flu vaccine] are like dead to the world for two or three weeks. Sticking something in your body. You don't really know what that stuff is."
>
> "Yeah, I bet you if you did research on people that did get [the flu vaccine] and people that didn't get it, I bet the turnout, the people that got the shot were sicker than those that didn't get it."

The survey data also indicated that outside of home childcare providers were concerned about influenza vaccination causing illness. While half of outside of home childcare providers agreed that seasonal influenza vaccination is safe, over one-third of outside of home childcare providers felt that the influenza vaccine can cause people to get influenza. Seventy-two percent of outside of home childcare providers agreed that H1N1 influenza was a serious disease but only forty-two percent agreed that the H1N1 influenza vaccine was safe (see Table 12). Attitudes and beliefs about seasonal and H1N1 influenza did not differ significantly between outside of home childcare providers and other employed adults.

Among outside of home childcare providers who were not vaccinated for influenza, fear of getting sick from the influenza vaccine was a top reason cited for not being vaccinated for both seasonal and H1N1 influenza (see Table 13). The reasons reported for not receiving seasonal influenza vaccination or H1N1 influenza vaccination did not differ between outside of home childcare providers and other employed adults.

Childcare providers have immunity
The childcare providers felt they built up immunity and antibodies by working closely with children and cited this as a reason why they did not need to be vaccinated for influenza.

> "I've been working with children for over 30 years and I never took a flu shot. I never got sick because again if you are around all of this, your body will naturally build up antibodies. You have to remember that."
>
> "…I feel like I already have a strong immune system. So, I don't take drugs of any kind, or medicine, or anything. That's just my personal belief."

> "I think I'm already immune to [the flu] because I already have the antibody due to working so long with the children."

While the survey did not ask respondents questions about their immunity to influenza, respondents did cite not needing the influenza vaccine as a top reason for not being vaccinated for seasonal and H1N1 influenza (see Table 13).

Natural remedies can be used to prevent and treat illness

Many childcare providers brought up the use of natural remedies to treat and prevent illness. Natural remedies were perceived as a better and perhaps safer alternative to traditional medicine.

> "I'd just like to mention I think it would be better, instead of trying to get the flu shot, give more information to the public on health habits or something like that garlic, like natural antibodies, ways to take care of myself the natural way."

> "…there are a lot of natural remedies that people can do and they need to more enforce that. They even need to teach this more in child development. They are not doing and it works. It's like magic."

> "When my immune system go very low, I just go get acupuncture. And acupuncture will start my immune system. I highly recommend it. I think it's better than conventional medicine because when I get something from conventional medicine, I don't really feel good.

Distrust of physicians and pharmaceutical companies

In line with the preference for natural medicine, several childcare providers also expressed distrust of pharmaceutical companies and physicians. There was concern that both physicians and pharmaceutical companies only encourage influenza vaccination to make money. Other childcare providers were resistant to the recommendations of physicians regarding the influenza vaccine.

> "We don't know. Only the physicians know. We don't know what happens with the vaccination. Many can tell you but only to get money from you." "Yes it is money. How [was it before] when people didn't get the flu vaccination?"

> "I had a fight with my doctor. No, I don't need the flu shot. I've never had one and I'm never sick. I'm like this every day. I'm never sick, but if I get sick it is only for a couple days and I'm back."

> "I don't get any of that stuff (referring to vaccines). I tell my doctor, 'Do it to yourself. Leave me alone.'"

> "But [physicians] are really pushing the flu vaccine down our throat. They really are because of our age."

Facilitators of Influenza Vaccination

Recommendations from healthcare providers

The only facilitator of influenza vaccination that emerged during the focus groups was recommendations or reminders for influenza vaccination from healthcare providers. While some childcare providers were distrustful of physicians, as discussed above, for others physician recommendations encouraged influenza vaccination.

> "…my doctor recommends the shots she wants me to have when I go in. So, I get them for that reason. I trust my doctor."

> "I get reminders by e-mail from CVS because that's where I have been going to get [the flu vaccine]. So, then I know that they are ready to start giving them to you."

> "…I think if the moment comes, I'll go to the doctor and if he tells me, 'You have to get the [flu vaccine] for this and that reasons perhaps I do it…"

As with the focus group participants, some outside of home childcare providers surveyed who were not vaccinated for influenza agreed that they would follow a healthcare provider recommendation to be vaccinated for influenza; although, many of the unvaccinated outside of home childcare providers reported they would not follow a healthcare provider recommendation for influenza vaccination. Only 38% of unvaccinated outside of home childcare providers reported they would get the seasonal influenza vaccine if a doctor or healthcare provider strongly recommended it; while 59% reported they would get the H1N1 influenza vaccine if a doctor or healthcare provider strongly recommended it (see Table 14). Self-reported willingness to follow healthcare provider recommendations did not differ between outside of home childcare providers and other employed adults.

Table 11. Influenza Vaccination Rates by Outside of Home Childcare Provider Status during the 2009-2010 Influenza Season

	Childcare Providers		Non-Childcare Providers	
	n	%† (95% CI)	n	%† (95% CI)
Seasonal influenza*	171	48.6 (36.1, 61.1)	1,684	31.8 (28.0, 35.6)
H1N1 influenza	171	28.5 (16.6, 40.4)	1,680	17.8 (14.8, 20.9)

† All estimates weighted to be nationally representative using data from the Current Population Survey

*Difference between childcare providers and non-childcare providers is significant ($p \leq 0.05$)

Table 12. Attitudes about Influenza and Influenza Vaccination by Outside of Home Childcare Provider Status during the 2009-2010 Influenza Season

	Childcare Providers*				Non-Childcare Providers			
	n	**Agree or Strongly Agree† % (95% CI)**	**Neutral† % (95% CI)**	**Disagree or Strongly Disagree† % (95% CI)**	**n**	**Agree or Strongly Agree† % (95% CI)**	**Neutral† % (95% CI)**	**Disagree or Strongly Disagree† % (95% CI)**
Seasonal flu is a serious disease.	169	48.3 (35.8, 60.8)	32.2 (19.9, 44.5)	19.5 (8.6, 30.4)	1,671	49.6 (45.3, 53.8)	34.0 (29.9, 38.2)	16.4 (13.3, 19.5)
Being vaccinated against seasonal flu is safe.	169	53.2 (40.5, 65.9)	36.3 (23.5, 49.0)	10.6 (2.6, 18.5)	1,680	56.4 (52.2, 60.6)	31.3 (27.3, 35.3)	12.3 (9.5, 15.1)
Being vaccinated against seasonal flu is worth the time and expense.	169	41.4 (29.6, 53.3)	45.3 (32.6, 57.9)	13.3 (3.9, 22.8)	1,679	39.8 (35.7, 43.8)	39.4 (35.2, 43.7)	20.8 (17.2, 24.3)
H1N1/swine flu is a serious disease.	169	71.6 (59.2, 83.9)	23.7 (11.5, 35.9)	4.7 (0.4, 9.1)	1,676	65.9 (61.7, 70.1)	27.1 (23.1, 31.2)	7.0 (4.8, 9.1)
Being vaccinated against H1N1/swine flu is safe.	171	42.3 (30.2, 54.5)	45.6 (33.0, 58.1)	12.1 (3.9, 20.3)	1,678	40.2 (36.1, 44.3)	43.8 (39.5, 48.0)	16.0 (12.9, 19.2)
Being vaccinated against H1N1/swine flu is worth the time and expense.	169	38.0 (26.3, 49.8)	41.9 (29.3, 54.5)	20.1 (9.2, 31.0)	1,676	35.7 (31.7, 39.6)	44.4 (40.1, 48.6)	20.0 (16.4, 23.5)
Flu vaccines can cause people to get the flu.	171	36.4 (24.5, 48.3)	30.5 (18.9, 42.1)	33.1 (21.3, 45.0)	1,675	35.6 (31.5, 39.7)	31.0 (27.2, 37.4)	33.3 (29.3, 37.4)
In general, vaccines are safe.	171	63.7 (51.6, 75.8)	29.4 (17.6, 41.1)	6.9 (1.8, 12.0)	1,675	59.1 (54.8, 63.3)	29.7 (25.8, 33.6)	11.2 (8.2, 14.3)

* There were no significant differences between responses from childcare providers and non-childcare providers

† All estimates weighted to be nationally representative using data from the Current Population Survey

Table 13. Reasons Reported for Not Being Vaccinated for Influenza by Outside of Home Childcare Provider Status during the 2009-2010 Influenza Season

	Childcare Providers*	Non-Childcare Providers
Reason for not being vaccinated	Seasonal Influenza† % (95% CI)	Seasonal Influenza† % (95% CI)
Don't need it	18.5 (4.7, 32.4)	32.8 (27.8, 37.9)
Don't believe in flu vaccines	16.5 (2.9, 30.1)	16.9 (12.9, 21.0)
I didn't get around to it	16.0 (2.9, 29.0)	12.3 (9.0, 15.7)
Other	12.7 (3.8, 21.6)	6.9 (4.5, 9.3)
Might get sick from the vaccine	11.1 (-1.2, 23.5)	9.1 (6.0, 12.1)
Flu vaccines cost too much	9.4 (-2.5, 21.3)	3.0 (1.2, 4.8)
Dislike needles	5.4 (-1.0, 11.8)	3.6 (1.6, 5.6)
There was no vaccine available when I went to get it	3.4 (-0.5, 7.4)	2.8 (1.2, 4.4)
Others need it more than I do	3.0 (-0.7, 6.7)	6.4 (3.6, 9.2)
Might experience side effects	2.5 (-0.4, 5.4)	3.8 (2.2, 5.3)
A doctor did not tell me I needed it	1.5 (-1.4, 4.4)	2.4 (0.9, 3.9)
Reason for not being vaccinated*	H1N1 Influenza† % (95% CI)	H1N1 Influenza† % (95% CI)
Other	16.1 (6.6, 25.5)	10.8 (7.8, 13.7)
Might get sick or experience side effects	15.2 (4.6, 25.7)	9.5 (6.9, 12.0)
Don't need it	14.4 (4.0, 24.9)	25.4 (21.1, 29.6)
Others need it more than I do	12.4 (1.5, 23.3)	11.0 (7.9, 14.1)
There was no vaccine available when I tried to get it	10.3 (3.6, 17.0)	6.5 (4.4, 8.6)
Didn't know enough about H1N1/Swine flu	9.85 (2.85, 16.9)	8.7 (6.4, 11.1)
Don't believe in flu vaccines	9.0 (0.1, 18.0)	15.1 (11.5, 18.7)
I got/will get a seasonal flu vaccine instead	6.7 (0.1, 13.3)	4.7 (2.5, 6.9)
Flu vaccines cost too much	4.2 (-3.8, 12.1)	2.2 (1.0, 3.4)
Dislike needles	0.8 (-0.6, 2.1)	3.9 (1.2, 4.7)
Didn't know where to get the vaccine	0.5 (-0.5, 1.5)	1.8 (0.5, 3.0)
It takes too much time to get the vaccine	0.5 (-0.5, 1.5)	1.5 (0.4, 2.6)

* There were no significant differences between responses from childcare providers and non-childcare providers ($p \leq 0.05$)

† All estimates weighted to be nationally representative using data from the Current Population Survey

Table 14. Receptivity to Healthcare Provider Recommendations for Influenza Vaccination by Outside of Home Childcare Provider Status during the 2009-2010 Influenza Season

	Childcare Providers*		Non-Childcare Providers	
	Seasonal Influenza† % (95% CI)	H1N1 Influenza† % (95% CI)	Seasonal Influenza† % (95% CI)	H1N1 Influenza† % (95% CI)
Would get a vaccine if a doctor or healthcare provider strongly recommended it	37.60 (18.03, 57.17)	59.11 (42.72, 75.50)	51.3 (45.6, 57.1)	52.6 (47.4, 57.7)

* There were no significant differences between responses from childcare providers and non-childcare providers (p≤0.05)

† All estimates weighted to be nationally representative using data from the Current Population Survey

Discussion

The attitudes expressed in the focus groups indicated that misinformation about influenza and influenza vaccination was prevalent among the childcare providers. Among the focus group participants, there was serious concern that influenza vaccines cause influenza as well as a belief that childcare providers build up immunity to influenza by working closely with children. The survey data confirmed that misperceptions about influenza vaccination are also present among the broader population of outside of home childcare providers. The beliefs that influenza vaccines can cause influenza and that one does not need to be vaccinated for influenza were main reasons reported for not receiving the influenza vaccine by outside of home childcare providers. Educational programs may help to clear up these misperceptions about influenza and influenza vaccination. One study found increases in the intention to be vaccinated for influenza among childcare workers following an educational program that provided information about vaccine-preventable diseases, and about the CDC's influenza vaccine recommendations for young children and adults who have close contact with young children (Hayney and Bartell 2005). Studies among other populations have also found that several different types of educational interventions were positively associated with influenza vaccine uptake (Crouse, Nichol et al. 1994; Armstrong, Berlin et al. 1999; Yudin, Salripour et al. 2010). The interventions included a mailed information sheet, an informational brochure provided to patients attending clinics, an educational video and brochure coupled with a workplace vaccine day. Childcare professional organizations (such as the National Association for the Education of Young Children (NAEYC) or the Association for Early Learning Leaders) and childcare center directors are in the position to provide educational information about influenza vaccination to childcare workers.

Although, educational campaigns may not be effective among all outside of home childcare providers because there seemed to be distrust of the influenza vaccine, physicians, and pharmaceutical companies among some childcare providers. While some childcare providers in the focus groups indicated that they followed their healthcare providers' recommendations or found reminders for vaccination to be helpful, other childcare providers were resistant to their healthcare providers' recommendations for influenza vaccination. Among these childcare providers, resistance to healthcare provider recommendations seemed to stem from distrust of physicians and the influenza vaccine. Likewise among the survey respondents, only 38% of unvaccinated outside of home childcare providers reported that they would be vaccinated for seasonal influenza if their healthcare provider strongly recommended it. This suggests we should consider other sources for influenza vaccination recommendations, such as childcare professional organizations. Several studies have found that peers can be influential when deciding whether or not to take up a vaccine (Chapman and Coups 1999; Tabbarah, Zimmerman et al. 2005; Dempsey, Zimet et al. 2006). Childcare professional organizations can make use of their influential status to provide education about and recommendations for influenza vaccination at their annual conferences as well as through mail and email correspondence with their members.

Interestingly, while the childcare providers in the focus groups were concerned about the spread of illness from the children for whom they care to themselves or to their family members, the possibility of childcare providers spreading influenza to the children never came up during the focus groups. This indicates that protecting young children may be an area where public health agencies and healthcare professionals can educate childcare providers about disease spread; however, more research is necessary to understand whether this knowledge gap extends to the broader population of childcare providers.

Despite having a higher risk for contracting and spreading influenza at their place of employment, the outside of home childcare providers surveyed held similar views about influenza vaccination as other employed adults. While outside of home childcare providers were vaccinated for seasonal influenza at higher rates than other employed adults, they were not vaccinated at higher rates for H1N1 influenza. Outside of home childcare providers also held similar attitudes and beliefs about influenza vaccination as other employed adults and were no more likely to report that they would follow healthcare provider advice to be vaccinated for influenza. This suggests that misperceptions about influenza and influenza vaccination are widespread among employed adults. Public health agencies, childcare professional agencies, and healthcare providers should work to provide correct information about influenza to childcare providers and the broader adult population.

The current study faces several limitations. As with any survey, respondent recall may bias the results. In particular during the 2009-2010 influenza season, respondents may have confused the seasonal and H1N1 influenza vaccines; although vaccine rates from the survey used in the current study match well with vaccine rates reported by the CDC (Centers for Disease Control and Prevention 2010). Additionally, the group of adults identified as outside of home childcare providers in the survey data may include a variety of individuals who work with young children on a day-to-day basis, including not just childcare workers but also others employed in fields that work with young children; however, the ACIP cites all adults who have close contact with children under the age of the five as a high priority group for seasonal influenza vaccination. Also, as with all studies using focus groups, the focus groups in this study did not include a large or nationally-representative sample of childcare providers; however, in the current study we found consistent results between the focus groups and the nationally-representative survey. The consistency in the findings gives us more confidence in the focus group results.

Childcare providers may hold incorrect beliefs about influenza and influenza vaccination, including that they do not need to be vaccinated for influenza and that the influenza vaccine causes one to become sick. Childcare providers may also be distrust of their physician's advice to be vaccinated for influenza. In light of this, childcare professional organizations and childcare center directors should convey accurate information about the safety, efficacy, and benefit of influenza vaccination among those who work with young children.

Policy Implications and Conclusions

The three papers included in this dissertation point to several recommendations which may lead to better access to influenza vaccination, greater awareness of the need for influenza vaccination, and an increase in influenza vaccine uptake among adults. There are five main recommendations that come from this work and the empirical literature:

- Increase access to influenza vaccination among parents, particularly during times of resource scarcity.
    - The study presented in Chapter 3 found that healthcare professionals with children in the household were more likely to be vaccinated for H1N1 influenza than healthcare professionals without children in the household. Given the shortage of H1N1 influenza during the 2009-2010 influenza season, this result suggests that access to the H1N1 influenza vaccine played a role in the decision to be vaccinated among healthcare professionals with children in the household. Other research indicates that one way to increase access to influenza vaccination and encourage vaccine uptake among parents is offering parents influenza vaccination when they take their children to pediatric office visits (Cooper White, Baum et al. 2010; Lessin, Edwards et al. 2012).
- Healthcare professionals should send mail, telephone, email, or text reminders for influenza vaccination to adults. Reminders may come from a variety of sources including healthcare professionals, employers, retail clinics, and public health agencies.
    - The results presented in Chapter 4 indicate that there is a positive association between receipt of reminders for influenza vaccination and influenza vaccine uptake among all adults; although, only 28 percent of adults aged 19 to 49 and 32 percent of adults aged 50 and older received a reminder of any type of influenza vaccination during the 2009-2010 influenza season. In this analysis, reminders may have come from healthcare professionals, public health agencies, insurance companies, retail clinics, or employers.
- Healthcare professionals should provide recommendations for influenza vaccination to all adults during visits to doctors' offices.
    - The results presented in Chapter 4 also point to a strong positive association between influenza vaccination and healthcare provider recommendations for influenza vaccination among adults who attend doctors' office visits. Yet, only 37 percent of adults aged 19 to 49 and 56 percent of adults aged 50 and older who attended a doctor's office visit during the 2009-2010 influenza season received a recommendation for any type of influenza vaccination.
- Childcare professional organizations and childcare center directions should provide education regarding the influenza vaccine's safety and efficacy through the form of educational brochures or educational information sessions.

  - The study presented in Chapter 5 found that misinformation about the influenza vaccine, particularly that it causes influenza, was a barrier to influenza vaccination among childcare providers. A study of childcare workers found increases in the intention to be vaccinated for influenza following an educational program that provided information about vaccine-preventable diseases, and about the CDC's influenza vaccine recommendations for young children and adults who have close contact with young children (Hayney and Bartell 2005). Studies among other populations have also found that several different types of educational interventions were positively associated with influenza vaccine uptake, including a mailed information sheet, an informational brochure provided to patients attending clinics, and an educational video and brochure coupled with a workplace vaccine day. (Crouse, Nichol et al. 1994; Armstrong, Berlin et al. 1999; Yudin, Salripour et al. 2010).
- Childcare professional organizations should recommend influenza vaccination to their members.
  - The study presented in Chapter 5 also found that among childcare providers distrust of physicians' advice was a barrier to influenza vaccination. In light of this, recommendations from other sources, such as childcare professional organizations, may be more effective than recommendations from physicians at encouraging influenza vaccine uptake among childcare workers.

Each of the strategies presented above has advantages and disadvantages as described in Figure 12. The strategies are assessed on a number of factors including: populations targeted, populations not reached, sector that would implement the strategy, cost, ease of implementation, and effectiveness.

1. *Increase access to influenza vaccination among parents, particularly during times of resource scarcity.*

   This strategy will target only those adults who have children in the household. Although this strategy does not reach the broad adult population, it will reach parents of children under the age of five who are a high priority for influenza vaccination according to the ACIP recommendations (Fiore, Uyeki et al. 2010). One way to increase access among parents is by providing influenza vaccination to parents during pediatric office visits (Cooper White, Baum et al. 2010). In terms of cost to pediatricians and parents, this strategy faces some challenges. Lessin et al. (2012) outline the challenges faced by pediatricians in offering influenza vaccination to parents and guardians. Briefly, pediatricians need to determine whether they can bill adults for influenza vaccination because some sources of influenza vaccine do not allow physicians to charge for the vaccine (Lessin, Edwards et al. 2012). Where they are able to bill, pediatricians need to determine whether they will bill parents' insurance or charge the parents directly for the immunization. For parents, this may also create the added cost of paying for the immunization out of pocket. There are also administrative costs and logistics to consider. Pediatricians would need to document that they provided each parent with the Vaccine Immunization Statement (Lessin, Edwards et al. 2012). Despite the challenges, many pediatricians' offices are offering influenza vaccination to parents. Among a random sample of pediatricians surveyed by the American Academy of Pediatrics in 2006, 51 percent of pediatricians reported usually or occasionally offering influenza vaccination to parents or guardians (AAP 2006). Parents also seem receptive to receiving influenza vaccination in pediatricians' offices. One study found that offering influenza vaccination to parents in a pediatrician's office improved the rate of vaccination from 24 percent in the prior influenza season to 87 percent in the current influenza season (Cooper White, Baum et al. 2010). In other settings where parents were offered vaccinations while obtaining healthcare for their children, the majority of parents were receptive to taking up the vaccine (Shah, Caprio et al. 2007; Dylag and Shah 2008). Offering influenza vaccination to parents in pediatricians' offices is not without challenges but it appears to be a promising way to encourage influenza vaccine uptake among parents.

2. *Healthcare professionals should send mailed, telephone, email, or text reminders for influenza vaccination to adults. Reminders may come from a variety of sources including healthcare professionals, employers, retail clinics, and public health agencies.* Reminders can be provided to any adult who has a usual source of care or who is on file within a health system, health insurance company, public health agency, retail clinic, or employer. While this will not reach all adults, the Affordable Care Act is expected to increase health insurance coverage to over 90 percent among non-elderly adults (Buettgens and Hall 2011). This means that much of the adult population will be reachable through their insurance company if not through their physician. The use of reminders through mail, telephone, or email requires additional staffing and possibly additional IT infrastructure. A study of mail or telephone physician reminder systems found a positive association between IT capabilities and implementation of physician reminders (Schmittdiel, McMenamin et al. 2004). For some large health systems, insurance companies, and employers sending mail or email reminders to patients may be easier to implement because these organizations are likely to communicate with patients regularly via mail and email. For other smaller medical practices, IT capabilities and staffing may be a barrier to providing patients with reminders. In terms of effectiveness, the current study presented in Chapter 4, as well as other research, found positive associations between reminders for influenza vaccination and vaccine uptake (Maurer and Harris 2011).

3. *Healthcare professionals should provide recommendations for influenza vaccination to all adults during visits to doctor's offices.*
   Healthcare professionals should target all adults with recommendations for influenza vaccination but only those adults who attend a doctor's office visit and are willing to comply with the recommendation will be impacted by this strategy. The cost of this strategy could be fairly low if physicians remembered to work recommendations into their routine office visits during influenza season. If a computer-generated reminder is required to prompt physicians to make the recommendation, then the costs are higher given the need for the IT capabilities necessary to implement the reminder system. The effectiveness of physician recommendations for influenza vaccination seems to be high as there was a strong positive association between physician recommendations and influenza vaccination among adults aged 19 to 49 and adults aged 50 and older during the 2009-2010 influenza season (see Chapter 4); although, the percent of adults receiving physician recommendations was low particularly for adults aged 19 to 49.

4. *Childcare professional agencies, and childcare center directions should provide education to childcare workers regarding the influenza vaccine's safety and efficacy.*
   This strategy specifically targets childcare providers based on the results of the analysis presented in Chapter 5. While this strategy will not impact all adults, it does focus on outside of home caregivers of young children who are a high priority group for influenza vaccination in the ACIP recommendations. Other research indicates that mailed information sheets, informational brochures, and educational videos may be effective ways to educate adults about influenza vaccination (Armstrong, Berlin et al. 1999; Hayney and Bartell 2005; Yudin, Salripour et al. 2010). The Centers for Disease Control and Prevention (CDC) offers information sheets and flyers about influenza vaccination targeted at adults who have close contact with young children (Centers for Disease Control and Prevention 2013; Centers for Disease Control and Prevention 2013). Childcare center directors and childcare professional agencies can make use of these resources to educate childcare workers about the importance and safety of influenza vaccination among childcare workers. This would make gathering the resources necessary for education low cost; although these groups would still face the administrative costs necessary to provide educational seminars, or to send educational mailings.

5. *Childcare professional organizations should recommend influenza vaccination to their members.*
   As with the above strategy, this strategy targets childcare providers based on the results of the analysis presented in Chapter 5. Again here, this strategy focuses on a group of adults who are high priority for influenza vaccination. This option should be low cost because childcare professional agencies can make use of national conferences to

recommend influenza vaccination to their members. In terms of effectiveness, other research suggests that peers can be influential when making vaccine uptake decisions (Chapman and Coups 1999; Tabbarah, Zimmerman et al. 2005; Dempsey, Zimet et al. 2006). More research is needed to understand whether childcare workers are willing to follow healthcare recommendations made by childcare professional organizations.

Overall the research presented here points to several options for policy interventions that may increase influenza vaccine uptake among adults. It is important to remember that actors from all sectors can play a role in increasing influenza vaccine uptake among adults. Adults should be targeted based on their specific characteristics, such as parent-status or employment. A variety of interventions, including ones not discussed here, will be necessary to increase influenza vaccine uptake among all adults.

Figure 12. Policy Options and Trade-Offs

Policy Options	Offer influenza vaccination to parents at pediatricians' offices	Healthcare professionals should recommend influenza vaccination to all adult patients during office visits	Healthcare professionals, public health agencies, and retail clinics should send reminders for influenza vaccination to all of their patients	Childcare professional organizations and childcare center directors should provide childcare workers with education about influenza vaccination	Childcare professional organizations should recommend influenza vaccination to their members
Population targeted	Parents	Adults who attend doctor's office visits during the influenza season	Adults with a usual source of healthcare	Childcare workers	Childcare workers
Sector that would implement	Private: Healthcare Professionals	Private: Healthcare professionals	Private: Healthcare professionals, Retail clinics	Private: Childcare centers, Childcare professional organizations	Private: Childcare professional organizations
Evaluation Criteria					
Target Population is high priority in ACIP Recommendations	Yes	Partially	Partially	Yes	Partially
Percent of Adult Population Reached	Low	Moderate	Moderate to High	Low	Moderate to High
Cost	Moderate	Moderate	Moderate	Low-Moderate	Low-Moderate
Ease of Implementation	High	Moderate to High	Moderate	Low	Low
Effectiveness	Uncertain	Positive	Positive	Uncertain	Uncertain
Populations not Reached	Other adults in household who do not attend the pediatrician's office visit	Adults who do not have a doctor's office visit during the influenza season	Adults who do not have a usual source of healthcare	Childcare workers who are not part of childcare professional organizations	Childcare workers who are not part of childcare professional organizations

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Appendix: Vaccine Model Calculations

$$e(1-s)\big(U(h_g)-c\big)+(1-e)(1-s)\big(U(h_b)-c-l_f\big)+es\big(U(h_g)-c-l_s\big)+(1-e)s\big(U(h_b)-c-l_s-l_f\big)>(1-p)U\big(h_g\big)+p(U(h_b)-l_f)$$

$$e(1-s)U\big(h_g\big)-e(1-s)C+(1-e)(1-s)U(h_b)-(1-e)(1-s)\big(c+l_f\big)+esU\big(h_g\big)-es(c+l_s)+(1-e)sU(h_b)-(1-e)s\big(c+l_s+l_f\big)>U\big(h_g\big)-pU\big(h_g\big)+pU(h_b)-pl_f$$

$$eU\big(h_g\big)+U(h_b)-eU(h_b)-(1-s)c-l_f+el_f-sc-sl_s>U\big(h_g\big)-pU\big(h_g\big)+pU(h_b)-pl_f$$

$$e\Delta U(h)+el_f>p\Delta U(h)+\Delta U(h)+c+(1-p)l_f+sl_s$$

$$e>\frac{(1-p)\Delta U(h)+(1-p)l_f+sl_s+c}{\Delta U(h)+l_f}$$

$$e>(1-p)+\frac{sl_s+c}{\Delta U(h)+l_f}$$

$$p>(1-e)+\frac{sl_s+c}{\Delta U(h)+l_f}$$

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