Distribution Agreement

Signature:

_______________________________ _____________

Abby L. Berns Date

The Role of Knowledge of the Universal Recommendation in Receipt of Influenza Vaccination during the 2011-2012 Flu Season.

By

Abby L. Berns

Master of Public Health

Epidemiology

David G. Kleinbaum

Committee Chair

Erin D. Kennedy

Committee Member

The Role of Knowledge of the Universal Recommendation in Receipt of Influenza Vaccination during the 2011-2012 Flu Season.

By

Abby L. Berns

Bachelor of Arts

Smith College

2008

Thesis Committee Chair: David G. Kleinbaum, PhD

An abstract of

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University

in partial fulfillment of the requirements for the degree of
Master of Public Health

in Epidemiology

2013

Abstract

The Role of Knowledge of the Universal Recommendation in Receipt of Influenza Vaccination during the 2011-2012 Flu Season.

By Abby L. Berns

Vaccination is the best method to prevent influenza, a disease that causes significant morbidity and mortality in adults and children. In February 2010, the Advisory Committee on Immunization Practices recommended that all individuals over 6 months of age receive influenza vaccination each year. This recommendation was intended to simplify vaccination delivery and increase coverage. Since the universal recommendation, vaccination coverage has remained relatively stable among adults, despite campaigns promoting the recommendation. No studies have previously examined the association between knowing the recommendation and receiving vaccination. The purpose of this study was to determine if knowledge of the universal recommendation is associated with receipt of influenza vaccination. The secondary goal of the study was to characterize those who know and don't know about the universal recommendation. Data were analyzed from the March 2012 National Flu Survey, a random-digit-dialed telephone survey of the US population.

Using multivariate logistic regression, we determined that people who knew about the universal recommendation were more likely to receive flu vaccination than those who did not know (Prevalence Ratio: 1.19, 95% CI 1.12, 1.27). Using Chi-squared analysis, we found that people who were female, had high risk health conditions, fell into a group previously recommended for vaccination and perceived themselves to be recommended were more likely to know about the universal recommendation than those who were male, without high risk conditions, were not previously recommended for vaccination and did not perceive themselves recommended (α=0.05). Those who believed that vaccine is safe or effective, those who believed themselves susceptible to influenza, and those who thought their daily activities would be disrupted by influenza were more likely to know about the universal vaccination, and were more likely to be vaccinated themselves. Using a second logistic regression model, we identified that sex, age, perception of being recommended, and belief of severity of and susceptibility to influenza were associated with knowledge of the universal recommendation. Our findings point to a need to increase public knowledge of influenza vaccination recommendations. Health communicators and immunization programs must collaborate to improve both knowledge of the universal recommendation and the receipt of vaccination.

The Role of Knowledge of the Universal Recommendation in Receipt of Influenza Vaccination during the 2011-2012 Flu Season.

By

Abby L. Berns

Bachelor of Arts

Smith College

2008

Thesis Committee Chair: David G. Kleinbaum, PhD

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University

in partial fulfillment of the requirements for the degree of
Master of Public Health

in Epidemiology

2013

Table of Contents

Introduction

Vaccination is the best method to prevent influenza, a disease that causes significant morbidity and mortality in adults and children (1). In February 2010, the Advisory Committee on Immunization Practices (ACIP) at the US Centers for Disease Control and Prevention (CDC) recommended that all individuals over 6 months of age receive an influenza vaccination each year (2). ACIP passed this universal recommendation after extensive review and discussion; it was the culmination of a gradual expansion of the groups recommended for flu vaccination (3). Before universal recommendation, 85% of the United States population fell into a group recommended to receive influenza vaccination (2). The change in guidelines was intended to simplify vaccine delivery and communication, and eliminate confusion regarding who is recommended to receive vaccine. The ultimate purpose was to increase vaccination coverage and reduce the incidence of influenza (4). One of the objectives of Healthy People 2020 is to increase the percentage of adults aged 18- 64 who receive annual influenza vaccination to 80%; working towards this metric was a goal of the universal recommendation (5).

Despite the expanded recommendation, adult influenza immunization coverage remained relatively stable during the 2010-2011 and 2011-2012 flu seasons, according to the Behavioral Risk Factor Surveillance System (BRFSS) (in each year) and the National 2009 H1N1 Flu Survey (in 2009-2010) (41.2% in 2009-2010; 40.5% in 2010-2011; 38.8% in 2011-2012) (6-8). Adults aged 18-49, who were newly recommended for influenza vaccination under the universal recommendation, had particularly low rates of vaccination (28.4% in 2009-2010 [non-high-risk]; 30.5% in 2010-2011 and 28.6% in 2011-2012 [all adults 18-49]) (6-8). Clearly, current coverage is lower than the Healthy People 2020 goal (5). One possible explanation is that the general public is not aware of the universal recommendation. While many studies have been conducted on reasons for the country's low rates of flu vaccination, few have focused on knowledge or awareness of the universal recommendation (9-14). However, Maurer has conducted research regarding the impact of an individual's knowledge of being recommended for influenza vaccination on vaccination receipt (15). Maurer found that the universal recommendation did not result in increased awareness of being recommended for vaccination, particularly among the newly recommended group (15). As of 2011, fewer than half of US adults knew that they were recommended to receive vaccination.

The impact of the knowledge of the universal recommendation on vaccination remains unknown. Many studies have determined that knowledge, attitudes and beliefs towards influenza and influenza vaccination are related to receipt of vaccination (10, 11, 13, 16-25). However, no published study focuses on the ways in which specific knowledge of the universal recommendation affects receipt of vaccination.

This study seeks to determine whether adults who knew about the universal recommendation were more likely to report receiving an influenza vaccination during the 2011-2012 flu season. This information may help determine the impact of the universal recommendation on influenza vaccination coverage, and add to the body of work on factors that influence behavior regarding vaccine acceptance. The secondary purpose of this study is to characterize those who knew about the universal recommendation. By identifying groups that do not know about the universal recommendation, we can tailor communications messaging specifically to those groups.

Background

Healthy People 2020

Healthy People 2020 (HP 2020) is a set of 10-year goals and objectives for improving the health of all Americans (5). One of the objectives of Healthy People 2020 is to increase the percentage of children and adults who are vaccinated annually against seasonal influenza. A specific goal within HP 2020 is to increase the percentage of non-institutionalized adults aged 18-64 who are vaccinated annually against seasonal influenza, with a target of 80% coverage with influenza vaccination. When the objective was set, the baseline vaccination coverage among this group was 24.9%, measured in the 2008-2009 season. Another goal within HP 2020 is to increase percentage of non-institutionalized adults aged 65 and older who are vaccinated annually against seasonal influenza from 66.6% to 90%. Much progress is required in order to approach these vaccination coverage targets.

History

In February 2010, the Advisory Committee on Immunization Practices (ACIP) recommended that all individuals over 6 months of age receive a yearly vaccination against influenza (2). Known as the universal recommendation, this pronouncement came at the end of ten years of incremental expansion of the US population recommended to receive flu vaccination (2-4, 15, 26-29). Before 2000, influenza vaccination was recommended for those at increased risk for complications from influenza: adults over 65, pregnant women in their second and third trimester, health care workers, residents of nursing homes, and adults and children with medical conditions that put them at increased risk for complications from influenza (30). Adults with chronic illness, also known as high-risk adults, included those with a variety of conditions: HIV infection, chronic metabolic diseases (including diabetes mellitus), renal dysfunction, hemoglobinopathies, or immunosuppression (30). In the year 2000, influenza vaccination was recommended for adults 50-64 years of age, making all individuals over age 50 recommended for vaccination (31). In 2002, the first group of healthy children (6 to 23 months of age) was added as a permissive recommendation (29, 32, 33). Women who would become pregnant at any point during the flu season and adults with household contact with children were also recommended for vaccination in 2002. The permissive recommendation for children became an official recommendation in 2004 (33). Persons with the following health conditions were determined to be at increased risk for flu complications and recommended for vaccination between 2000 and 2005: any condition that can compromise respiratory function (e.g., cognitive dysfunction, spinal cord injuries, seizure disorders, or other neuromuscular disorders), chronic disorders of the pulmonary system (including asthma), and chronic disorders of the cardiovascular system (33, 34). At the beginning of the 2005-2006 flu season, two-thirds of the US population were recommended for influenza vaccine (4).

Approaching a Universal Recommendation

2005 Meeting: Universal Vaccination Against Influenza: Are We Ready?

In October, 2005, Walter Orenstein convened a special meeting of influenza vaccination experts, public health practitioners, vaccine manufacturers, and representatives of managed care organizations to discuss the potential expansion of flu vaccination recommendations to include all people in the US (3). At this meeting, experts from all of the aforementioned sectors presented research on the potential programmatic and public health implications of such an expansion. The meeting was entitled *Universal Vaccination Against Influenza: Are We Ready?*

Various arguments were presented in favor of expansion. A primary discussion point was simplicity (4). Historically, groups with age-based recommendations have attained higher levels of coverage than risk-based groups, due, in part, to the ease of determining that the person fits in the recommended group (4). In the 2004-05 season, children 6-23 months of age, who were newly recommended, received flu vaccination at a higher rate than high-risk children, who had long been encouraged to receive vaccination (35). Determining influenza vaccination eligibility of individual patients was often difficult and time-consuming for health care personnel. Simplifying the clinical decision-making and vaccine delivery processes was an argument in favor of the universal recommendation, which would allow providers to offer vaccine to any patient who presented in the office (2, 3).

Cost effectiveness of adding groups to the recommendation was also discussed. Vaccination of younger, working adults has been found to be cost effective, reducing provider visits, productivity loss and illness (36-38). Nichol et al. estimated that influenza vaccination reduced work loss by 18.4 days per 100 persons, and reduced days of work at reduced effectiveness by 26.9 days per 100 persons (37). In healthy, working adults, influenza vaccination had a mean cost savings of $13.66 per person vaccinated (38). Citing these studies, presenters predicted that universal vaccination against influenza would increase vaccination rates and decrease illness in many age groups.

Despite compelling evidence pointing toward the benefits of universal recommendation, it was thought that the vaccine supply and delivery mechanisms at the time could not keep up with the demand that would be generated by the recommendation (4). Rather than expand the recommendation all at once, participants in the meeting decided to recommend that ACIP incrementally increase the recommended groups, with an initial focus on expansion among children (3). Since pediatricians were already providing influenza vaccine, participants believed that vaccinating additional age groups would not stress existing delivery systems. Given that children have higher attack rates and transmit influenza more efficiently than adults, increased vaccination in children was predicted to have a greater impact on community transmission of flu (29). A decrease of transmission by children would hopefully lead to a decrease in incidence of influenza in the general population.

The results of this meeting were reported to the Advisory Committee on Immunization Practices (ACIP) in February 2006. At that meeting, a motion was passed to move towards a universal recommendation (39). At that time, ACIP expanded the recommendation to include children 2 to 4 years of age, with adult recommendations remaining limited to individuals over 50 years of age and those at high risk of complications from influenza. At the June 2006 meeting, ACIP voted to incrementally expand the recommendation, planning for the possibility of universal recommendation by 2013 (39). The plan was to expand the recommendation to all children, adding children 5-18 years of age in 2008-2009 and household contacts and caretakers of these children in 2010-2011. ACIP decided to consider expanding the recommendation to all adults in 2012-2013.

2007 Consultation and Subsequent ACIP Meetings

In 2007, CDC and the Council of State and Territorial Epidemiologists held a consultation to once again review the possibility of universal vaccination, specifically among children up to 18 years of age. Once again, expansion seemed logical from a disease-prevention perspective. However, potential challenges to implementation of a universal recommendation were raised (28). These challenges included the potential burden of increased visits to the medical home, as well as the difficulty in getting adolescents to a health care provider. Many adolescents do not have a medical home, and therefore reaching them through providers' offices might prove ineffective. School-located vaccination had not been intensively studied, and the increased demands on our vaccine delivery systems were determined to be too great. There were additional concerns about vaccine supply carrying over from the 2004-05 influenza vaccine shortage. As a result of these concerns, meeting participants continued to favor incremental expansion (28).

In 2008, ACIP voting members decided to expand the influenza vaccination recommendation to all children aged 6 months to 18 years, adding children 5 to 18 years to the recommendation. According to the plan proposed in 2006, this recommendation would be implemented in the 2008-2009 season (26, 39). This decision made the United States the first country to endorse a universal pediatric influenza immunization policy (29). Vaccination of healthy adults remained a permissive recommendation (39).

At the beginning of the 2009-10 flu season, there were over 20 distinct indications for flu vaccination, ranging from age to types of employment (40). Eighty-five percent of the US population fit into one of these categories, with over 260 million individuals recommended for annual flu vaccination (2, 27, 41). The only groups who remained excluded from the recommendation were non-pregnant adults between 18 and 49 years of age, without increased risk of complications from influenza, occupational risk, or close contact with those at risk.

2009 H1N1 Pandemic

In April 2009, the first cases of influenza A (H1N1) 2009 infection were confirmed in the United States (42). By June 11, 2009, the World Health Organization had declared a worldwide pandemic of the novel virus, which infected a younger demographic than seasonal influenza (43). Distribution of an influenza A (H1N1) 2009 monovalent vaccine began on October 5, 2009, shortly before the fall peak of the pandemic, the week ending October 24 (44). Although the goal was to eventually vaccinate all individuals with pandemic vaccine, the timeline of vaccine production led to the specification of initial target groups: pregnant women, people who lived with or cared for infants younger than 6 months of age, health care and emergency medical services personnel, individuals 6 months through 24 years of age, and adults 25 through 64 years of age who were at higher risk for 2009 H1N1 complications because of chronic health disorders or compromised immune systems (43). Adults over 65 years of age were not considered part of this initial target group; for the 2009 H1N1 pandemic, their hospitalization rates were less than 20% of typical flu hospitalization rates among that age group (43). State and local health departments were given flexibility in when they opened up vaccination to the general population. By late December, vaccine was available to anyone who wanted it, including those not in initial target groups. At the end of 2009, approximately 61 million people had received vaccination against 2009 H1N1influenza (45).

It is difficult to compare coverage in recent years with the 2009-2010 flu season. The groups targeted or recommended for pandemic vaccination were different than those groups recommended for seasonal influenza vaccination, and the pandemic most likely generated more interest in both seasonal and pandemic vaccine than a typical season.

Individuals may have been unaware of the need for both vaccines, and consequently received only one. Additionally, people may have been confused about which vaccine they received, and reported receiving one when they actually received the other. Therefore, estimates of coverage from 2009-2010 may not be completely comparable to coverage estimates in the years following the recommendation. However, the vaccination outreach and groups recommended for vaccination in that year set the stage for universal recommendation.

Immunization coverage with influenza A (H1N1) 2009 monovalent vaccine varied greatly by state and target group (45). Nationwide coverage among the initial target groups was 34.2%, with 22.7% coverage among all adults over 18, and 27% coverage among all persons. These estimates were based upon combined data from the Behavioral Risk Factor Surveillance System and the National 2009 H1N1 Flu Survey (7). Coverage with seasonal vaccine was higher than coverage with H1N1 vaccine: 41.2% seasonal influenza vaccination coverage among all persons, with 40.4% coverage of adults over 18 years of age (7). The H1N1 pandemic provided a unique opportunity to vaccinate different recommended groups than were typically targeted for influenza vaccination, such as young adults 19-25 years of age. Adequate stocks of vaccine later in the season served as a precursor to a universal recommendation, proving that the vaccine supply was sufficient for an increased recommendation for vaccination. In addition, H1N1 both necessitated and facilitated the use of alternative vaccination sites, such as schools, places of worship, shopping malls, and pharmacies. Innovative and unusual vaccination locations showed successful vaccination was possible even outside of a medical home. Vaccine supply and the difficulty of vaccinating without a medical home were two previously identified reasons not to move to universal recommendation for influenza vaccination (4, 28). In several ways, the H1N1 pandemic made possible the passing of the universal recommendation.

Universal Recommendation

At the February 2010 meeting, ACIP voted unanimously to pass a recommendation for universal influenza vaccination, stating that all individuals over 6 months of age in the United States should receive an annual influenza vaccination beginning in the 2010-11 flu season (2, 40). Although, by the original timeline proposed in 2006, ACIP did not intend to address universal recommendation until the 2012-13 season, it made sense to capitalize on the interest in flu vaccination generated by the 2009 H1N1 pandemic (39).

A major reason for expanding the recommendation at this time was the continued circulation of the 2009 H1N1 strain, to which healthy young adults were especially vulnerable (2, 46). During the pandemic, college students and other younger adults had high rates of severe disease and hospitalization from H1N1 influenza (47). Recommending universal vaccination would make it easier to reach the healthy younger adult age group (ages 18-49), who had not previously been recommended for seasonal vaccination. The mean age of death from H1N1 was 37 years, compared to the mean age of death from seasonal flu, which was 76 years (39). Vaccination rates of adults during the H1N1 pandemic were quite low: 16.7% of adults aged 25-64 who were not part of the initial target group were vaccinated, and 22.7% of all adults over 18 years (7). Therefore, immunity to 2009 H1N1 in the healthy young adult population could not be assumed. Additionally, even in non-pandemic years, hospitalization and deaths occur each year in healthy adults. Therefore, an increase in vaccination in 18-49 year-olds could lead to a reduction in morbidity and mortality due to influenza (2). For the reasons outlined above, the moment was right for a decision to move to a universal recommendation for influenza vaccination.

After the Recommendation

Passed in February 2010, the universal recommendation took effect in the 2010-2011 flu season. The CDC communications department launched awareness campaigns to inform the general public that everyone should now seek flu vaccination. One of the main campaigns, "The Flu and You," featured the multiple choice question: "Who should get a flu shot" with all of the answer choices "You." Various posters, radio PSAs, and bus ads featured racially diverse individuals of all ages stating reasons they were getting vaccinated.

Despite efforts on the part of CDC, local and state health departments, and health care professionals, rates of influenza vaccination among adults over 18 years of age remained stable in the two seasons following the recommendation (40.4% in 2009-2010, 40.5% in 2010-2011; 38.8% in 2011-2012) (6-8). These rates are based on BRFSS data in 2010-2011 and 2011-2012, and combined data from BRFSS and the National 2009 H1N1 Flu Survey (NHFS) in 2009-2010. In the 2011-12 flu season, adults aged 18-49 (the age group added by the universal recommendation) had the lowest rates of vaccination among any group (28.6% vaccinated, compared to 42.7% among adults aged 50-64 and 64.9% among adults 65 and older) (6). Coverage among high-risk adults 18-49 remained level (38.2% in 2009-2010, 39.0% in 2010-2011; 36.8% in 2011-2012) (6-8). Coverage increased among African-Americans over 6 months of age after the universal recommendation, then plateaued (33.7% in 2009-2010, 39.0% in 2010-2011; 39.0% in 2011-2012) (6-8). The same pattern existed for Hispanic individuals over 6 months of age (33.6% in 2009-2010, 40.0% in 2010-2011; 39.3% in 2011-2012). Coverage among non-Hispanic whites stayed nearly the same (43.9% in 2009-2010, 44.3% in 2010-2011; 43.1% in 2011-2012). Clearly, the universal recommendation did not immediately result in increased influenza vaccination.

Knowledge, Attitudes and Beliefs and Flu Vaccination

The relative stability of vaccination rates after the universal recommendation may be attributable to a variety of elements. Many factors contribute to an individuals' decision to receive or not to receive vaccination. Multiple studies have been conducted detailing reasons for non-vaccination (9-14, 48). Many factors contribute to vaccination behavior. Galarce, Minsky and Viswanath found that the most commonly mentioned reasons for not receiving H1N1 vaccine were not being in a priority group, concerns about side effects, not liking injections, and not knowing where to obtain vaccine (10). Santibanez et al. reported that 25% of older adults who did not receive flu vaccine in the 2003-04 season did not believe that they needed a flu shot, and 20% were concerned about side effects or the potential of contracting influenza from the vaccine (11). In a review of 21 studies of influenza vaccination attitudes in health care workers, Hollmeyer and colleagues reported that fear of adverse reactions and lack of concern about the flu were the top reasons cited for non-vaccination (9). In other studies, commonly cited reasons for non-vaccination reasons were fear of needles, not being in the habit of receiving a flu shot, not feeling susceptible to influenza, or feeling that vaccines had been developed too quickly (in the case of the H1N1 pandemic) (12-14).

Many of the factors individuals cite when choosing not to receive vaccination can be characterized as knowledge, attitudes, and beliefs (KABs)—concerns about safety and side effects of the vaccine, not being concerned about getting the flu, belief that influenza is not severe, and belief that vaccination is not effective against influenza (12, 13). Knowledge, attitudes and beliefs are significantly related to the decision to receive or not to receive a flu vaccine (10, 11, 13, 16-23). Those with greater knowledge of, more positive attitudes towards, and greater belief in flu vaccination are more likely to have been vaccinated (10, 11, 13, 16-21). People who believe that the flu vaccine is very or somewhat effective against influenza are more likely to receive vaccination, compared to those who feel it is ineffective or somewhat ineffective (10, 11, 13, 16-21). These metrics have a significant relationship with the behavior of vaccination. We cannot say whether this relationship is causal, but we can say that many KABs are related to vaccination. Although KABs have been well-studied in their relationship to receipt of vaccination, the implementation of universal recommendation brings a specific knowledge item to the forefront of KAB and vaccination research: knowledge of the universal recommendation.

Knowledge of the Universal Recommendation

An individual's knowledge, attitudes, and beliefs about flu and flu vaccination can influence the receipt of influenza vaccination. However, it is unknown if the specific knowledge of the universal recommendation is related to vaccine acceptance. Very little research examines the ways in which the specific knowledge of the vaccine recommendations affects the action of vaccination. A few studies detail the awareness of certain recommendations, but no post-universal recommendation research has focused on the relationship between this knowledge and vaccine behavior.

In a study examining KABs and vaccination among older adults, Santibanez et al. found that 77.9% of adults between the ages of 50 and 64 who were *not* vaccinated in 2003-04 knew that annual flu vaccination was recommended for their age group (11). These data were collected four seasons after the expansion of the recommendation to this age group. This study shows that among a group that had been recommended for vaccination for four years, most individuals who chose not to receive vaccine knew that they were recommended to receive it. This research provides evidence that knowledge of a recommendation does not mean that a person follows that recommendation. As most of the people who were not vaccinated in Santibanez's sample knew about the recommendation, it is clear that factors other than knowledge contributed greatly to non-vaccination among this group. The conditions of this study were similar to the conditions of the 2010 universal recommendation, as there was a "universal" recommendation within the age group studied. However, awareness of the recommendation was only examined among those who did not receive vaccine. Therefore, the study cannot provide any conclusions on the knowledge among those who did receive vaccine. This study provided descriptive data on awareness of recommendations, but did not look at the relationship between awareness and vaccination. In addition, this research examined whether a person believed himself to be recommended, but not whether the person knew the details of the recommendation itself. In our study, we seek to further examine awareness of recommendations, among both vaccinated and unvaccinated individuals.

Maurer et al. conducted two studies on adults' awareness of vaccination recommendations (15, 49). In a study of adults recommended to receive vaccine at the end of the 2009-2010 H1N1 pandemic, Maurer and colleagues estimated adults' awareness of being recommended for seasonal and/or 2009 H1N1 flu vaccination (49). The study sample included only individuals recommended to receive vaccine under the 2009 ACIP recommendations for seasonal influenza vaccination. Respondents reported inclusion in a group that was recommended to receive vaccination. . Only 32.6% of these adults correctly identified themselves to be recommended for seasonal influenza vaccination. A second study sample consisted of adults who were recommended by ACIP to receive 2009 H1N1 vaccine. Only 29.5% of the adults recommended for H1N1 vaccination knew that they were recommended. This awareness of a risk-based recommendation is a striking contrast to Santibanez's age-based recommendation study, in which adults in universally recommended age groups reported high levels of awareness (11). From these studies, it appears that levels of awareness in groups recommended based on risk factors are fairly low, while awareness in age-based recommended groups is higher. The Santibanez and Maurer studies lead to the question of whether there would be high levels of recommendation awareness when all individuals are covered by the universal recommendation.

In a second study, conducted after the 2010 ACIP recommendation, Maurer specifically examined whether the universal recommendation led to increased awareness, characterizing those who know and do not know they are recommended for vaccination (15). During the 2010-2011 flu season, they found that 46.2% of adults over 18 years had correctly identified themselves as being recommended for vaccine. Once again, Maurer asked whether adults believed themselves to be in a recommended group, rather than asking them to identify age groups included in a recommendation. While his results present an improvement from his 2009-2010 study, where only 32.6% of adults knew they were recommended, Maurer's further characterization of the respondents revealed wide variation in awareness. Adults who were newly recommended for seasonal vaccination under the universal recommendation (aged 18-24 without a risk condition) had the lowest awareness (23.9% aware), while adults over 65 with high-risk conditions, long since recommended for vaccine, had the highest level of awareness of being recommended for vaccination(88.3% aware). Adults 18-49 with high-risk conditions, and adults 50-64 with high-risk conditions, were 41.4% and 73.7% aware, respectively. The study did not examine self-reported recommendation coverage in adults 18-49 without high-risk conditions, which would have more completely represented newly recommended adults.

Maurer also found that awareness significantly differed by race/ethnicity and employment status (15). Black and Hispanic adults were significantly less likely to know their recommendation status, while those who were not working (including retired individuals) were more likely to be aware of the recommendation. However, in a model controlling for 2009-2010 recommendation status, there was no association between race and knowledge of recommendation status. People who were previously recommended for vaccination were much more likely to know their recommendation status than those who were newly recommended. Despite Maurer's work on the awareness of being recommended under the universal recommendation, no one has yet studied the relationship between the knowledge of the universal recommendation and receipt of influenza vaccine.

Research Questions and Implications

The current research gap regarding the impact of the universal recommendation is potentially significant; we seek to bridge that gap. ACIP moved to the universal recommendation on the assumption that clarity and knowledge of vaccination recommendations would make a difference in vaccination rates. However, we do not know if this is true. It is possible that knowledge of a recommendation does not influence the behavior of vaccination receipt. The main goal of our study is to determine if knowledge of the universal recommendation was associated with receipt of influenza vaccination in the 2011-2012 flu season.

Much effort has been put into campaigns that seek to raise awareness of influenza vaccination recommendations, under the assumption that increased knowledge will lead to increased vaccination. Examining whether this assumption holds true will allow us to see whether our communication efforts are on target or misguided. In this study, we seek to help answer the question, is knowledge enough?

By design, the universal recommendation should simplify influenza vaccination communication and promotion (15). However, communication about vaccination, while essential, has always been complicated. A meta-analysis of 10 years of influenza communication research found that misperceptions about influenza and flu vaccine have persisted despite numerous communications efforts (50). In particular, individuals "who considered themselves to be young, healthy, rarely ill, and protected by a strong immune system" believed that did not need to be vaccinated against influenza (50). It is likely that this group corresponds with the 18-49 year-old adults without conditions that would make them more susceptible to complications from influenza who were newly recommended in the 2010 universal recommendation. The meta-analysis suggested that promoting influenza vaccination as part of a healthy lifestyle could appeal to the 18 to 49 year-old age group. In addition, the meta-analysis noted that messaging needs to continue to promote the universal recommendation, focusing on the idea that flu vaccination is for everyone.

The secondary goal of the study is to characterize those who know and don't know about the universal recommendation by demographics, and knowledge, attitudes, and beliefs. By determining who knows about universal vaccination, we can focus targeted communications campaigns on groups lacking that knowledge. Assessing knowledge of the universal recommendation will also help to assess how successful we have been in promoting universal vaccination.

Much remains to be done in order to increase the rates of influenza vaccination and protect the adult population of the United States from influenza infection; this research could help move us towards the Healthy People 2020 goal of 80% influenza vaccination coverage among adults 18-49 years of age. If knowledge of the universal recommendation correlates with increased vaccination coverage, it will be especially important to work towards increasing public awareness of the universal vaccination recommendation.

Methods

Study Design and Sample

Data for this study come from the March 2012 National Flu Survey, a random-digit-dialed telephone (both landline and cell phone) survey sponsored by the Centers for Disease Control and Prevention. The aim of the survey was to provide end-of-season estimates of influenza vaccination coverage in the US, and to assess demographic, behavioral and belief questions related to influenza vaccination. The survey was conducted in both English and Spanish, and over-sampled certain areas to increase proportional representation among Hispanic, non-Hispanic Black, and non-Hispanic Asian populations. In the landline sample, the questionnaire was administered to the youngest male 18 years and older currently at home. If there were no males at home, the questionnaire was given to the youngest female 18 years and older. This screening method is a tested approach for balancing the age and gender of respondents. In the cell-phone sample, the adult who answered the cell phone was selected for the interview.

The Council of American Survey Research Organizations (CASRO) response rate was 31.4% for landlines and 18.3% for cell phones, and a total of 15,630 of adults aged 18 years and older completed interviews between March 1 and 29, 2012. Of these interviews, 1,763 had unknown or missing responses to the main exposure (knowledge of the universal recommendation) and were excluded from the sample. After these exclusions, 13,867 was the final study sample size. To account for complex survey design, NORC at the University of Chicago weighted all data based on population controls, adjusting for sampling probability within a household, landline and cell-phone sampling issues, and person and household non-response (18).

Measurement

Knowledge of Universal Recommendation

The main exposure measured in this study was knowledge of the universal recommendation for influenza vaccination. This knowledge was assessed with the question, “To the best of your knowledge, for which age group is the flu vaccine recommended?” Six different choices were provided: For Children under 6 Months of Age; For All People 6 Months of Age and Older; For Children 6 Months Through 18 Years and Adults Age 65 and Older; For Everyone Over 18 years of Age; For Children Under 18 Years of Age and Adults Age 65 and Older; and For People 65 and Older. The correct answer was “For All People 6 Months of Age and Older.” This response was coded as “1” if correct with all other (i.e., incorrect) responses coded as “2.”

Vaccination Receipt

Self-reported vaccination is the primary outcome of this study and was measured by a single question: “Since July 1, 2011, have you had a flu vaccination? It could have been a shot or a spray, drop or mist in the nose.” This variable was coded as “1” if the answer was “yes” and “2” if the answer was “no.”

Knowledge, Attitude, and Belief Covariates

Knowledge, attitudes, and beliefs about flu vaccination are well-documented predictors of vaccine receipt, and were therefore included in the study (10, 11, 16-20). Four knowledge, attitude, and belief (KAB) questions asked in the NFS were analyzed. These questions assessed the respondent’s knowledge, attitudes and beliefs towards the following factors: safety of vaccine (How safe do you think the flu vaccine is? Would you say very safe, somewhat safe, somewhat unsafe or very unsafe?); efficacy of vaccine (How effective do you think the flu vaccination is in preventing the flu? Would you say very effective, somewhat effective, not too effective, or not at all effective?); susceptibility to flu (In general, if you do not get a flu vaccination during a flu season, what do you think your chances are of getting the flu? Would you say very high, somewhat high, somewhat low, or very low?), and severity of influenza infection (Thinking about your ability to carry out your usual activities, do you think your usual activities would be very affected, somewhat affected, not very affected or not affected at all if you got the flu?). Each question used a four-point Likert response scale, and responses were dichotomized. The variables were referred to as Safety, Efficacy, Susceptibility, and Severity. An additional knowledge question asked whether people believed themselves to be in a group recommended for flu vaccination, with a yes/no response.

Additional Covariates

Recent doctor's visit and provider recommendation can significantly influence an individual's decision to receive vaccination (11, 51-53). Whether or not respondents visited a health care provider about their own health since July 1, 2011, and provider recommendation for flu vaccination were two variables included as potential covariates. The latter question asked whether a provider had recommended a flu vaccine to the respondent. The potential responses were as follows: provider recommended to receive flu vaccine, provider recommended not to receive flu vaccine, and provider did not recommend either way. Provider recommendation had a high percentage of missing data (29% missing). Missing provider recommendation values are due to the structure of the questionnaire; only those who reported visiting a doctor since July 1, 2011 were asked if a provider had recommended vaccination. Provider recommendation was excluded from the analysis due to the missing data, and provider visit was retained.

The presence of high-risk health problems was measured as well, combining the responses to several questions about self-reported health conditions into one “high-risk” variable. These health conditions include asthma, diabetes, heart disease, liver conditions, weakened immune systems, lung conditions other than asthma, kidney conditions, obesity, sickle cell anemia or other anemia, and neurological or neuromuscular conditions, and were indications for flu vaccination in adults between 18 and 49 years of age in the years before the universal recommendation. These health issues place individuals at higher risk of complications from influenza.

A variable was created to measure inclusion in a recommended group prior to 2010. It combines variables measuring respondent high-risk health condition, household contact with persons with high-risk health conditions, close contact with an infant under 6 months, and health care workers with direct patient contact, as well as individuals over 50 years of age. Pregnant women were not included, as it is a short-term recommendation for a given individual based due to the duration of pregnancy.

Demographic Covariates

In both descriptive and modeling analysis, age was treated as a categorical variable rather than a continuous one. It was divided into three categories: 18-49, 50-64, and 65 and over. This division reflects the progression of the ACIP influenza vaccination recommendations, with 18-49 year-olds as the newest recommended group (17).

Income was represented by a variable containing the poverty status of a respondent’s household. The variable was based on the number of people reported in a household, the reported household income (exact or within a range) and the 2009 Census poverty thresholds. The income variable had a high percentage of missing responses

(28% of respondents), and was therefore dropped from analysis before the model was fit. Education and race/ethnicity will serve as proxies for socioeconomic status in this analysis.

Additional demographic variables included in the analysis were as follows: race/ethnicity (a combined variable including both race and ethnicity, imputed), sex (imputed) and education level. NORC imputed race/ethnicity and sex variables using a hot-deck imputation procedure.

Interaction Terms

Adults 65 and over have been recommended to receive flu vaccine since the 1980's, with influenza vaccine becoming covered by Medicare in 1993 (54). Adults between 50 and 65 years of age have been recommended since 2000, and healthy adults between 18 and 49 were recommended in 2010. Therefore, it is likely that age modifies the effect of knowledge of the recommendation on the receipt of vaccination. To account for this potential, the interaction of age and knowledge of the universal recommendation has been included in the analysis (Recommendation Knowledge*Age). To this end, the interaction of being previously recommended for vaccination and knowledge of the recommendation has also been included in the analysis (Recommendation Knowledge*Previous Recommendation).

Analysis

Data were cleaned by NORC at the University of Chicago, and analyzed using SAS (SAS Inc., Cary, NC, USA) and SAS-callable SUDAAN (Research Triangle Institute, Research Triangle Park, NC, USA) to account for the complex survey design.

Descriptive analyses were carried out on all covariates, including assessing the association between the primary exposure variable (Knowledge of the Universal Recommendation) and the outcome variable (Receipt of Vaccination) and associations between the exposure variable and other covariates. Percentages of those who knew about the universal recommendation were calculated by vaccination status, sex, education, age, income, race/ethnicity, provider visit, previous recommendation, high-risk health condition, perception of being in a recommended group, severity, susceptibility, efficacy, and safety. Wald Chi-squared analysis was used to measure strength of association (α=0.05).

Weighted, unadjusted rates of vaccination coverage in the 2011-2012 season were calculated for each level of each variable, using PROC CROSSTAB in SAS-Callable SUDAAN to account for complex survey design. Wald Chi-squared analysis was used to measure any significant differences in vaccination coverage within variables. (α=0.05).

Logistic Regression Modeling

Due to the cross-sectional nature of this study, prevalence ratios were used as a measure of effect. In order to account for complex survey design, PROC MULTILOG in SAS-callable SUDAAN was used to calculate all prevalence ratios and to build logistic regression models. Although log-binomial modeling is more direct for the calculation of prevalence ratios, logistic regression modeling was used in this study, due to complex survey design and lack of readily-availability of software for log-binomial modeling with complex survey data (55). Unadjusted prevalence ratios and 95% confidence intervals were calculated between each variable and the outcome (receipt of vaccine in the 2011-2012 flu season). To calculate adjusted prevalence ratios, a multivariate logistic regression model was constructed, with knowledge of the universal recommendation as the exposure, and self-reported receipt of vaccination as the outcome. All covariates were included in the initial model, including selected product terms that considered the interaction of Recommendation Knowledge with Age and Previous Recommendation. A hierarchical backwards elimination strategy was used to determine the best multivariate model. The mathematical form of the starting model is given as follows:

Logit P(**X**) = β_0+ β_1(Recommendation Knowledge)+ β_2(Age) + β_3(Sex) + β_4(Education) + β_5(Race/Ethnicity) + β_6(Doctor Visit) + β_7(Previous Recommendation) + β_8(High Risk Condition) + β_9(Awareness of Being Recommended) + β_{10}(Severity) + β_{11}(Susceptibility) + β_{12}(Efficacy) + β_{13}(Safety) + β_{14}(Recommendation Knowledge*Age) + β_{15}(Recommendation Knowledge* Previous Recommendation)

Collinearity Diagnostics

In order to assess collinearity, an unweighted logistic regression model was created, with knowledge of the universal recommendation as the exposure, vaccination as the outcome, and the following covariates: sex, education, age, ethnicity/race, doctor's visit, high risk health condition, previous recommendation status, perception of being in a recommended group for vaccination, belief of efficacy of flu vaccine (efficacy), concern about contracting flu without vaccination (susceptibility), belief in safety of vaccine (safety), perception of severity of the flu (severity), previous recommendation*recommendation knowledge, and age*recommendation knowledge (See model in above section).

Modeling Strategy Results

Collinearity was assessed between all covariates, using the SAS macro developed jointly at Emory and CDC (56). The highest condition index observed was 110.862, which suggests a possible collinearity problem. Corresponding to this condition index, we found high VDP's on Recommendation Knowledge (0.935), Previous Recommendation (0.925), and the product of Recommendation Knowledge with Previous Recommendation (0.944), as well as on the intercept (0.804). We removed the product term of Recommendation Knowledge * Previous Recommendation, and the collinearity diagnostic model was run again. The highest condition index observed was 39.554. Only the intercept had a high VDP (0.997). The model was determined to be free from collinearity issues, and ready to be assessed for confounding and interaction.

The mathematical model at this stage was as follows:

Logit $P(\mathbf{X}) = \beta_0 + \beta_1$(Recommendation Knowledge)+ β_2(Age) + β_3(Sex) + β_4(Education) + β_5(Race/Ethnicity) + β_6(Doctor Visit) + β_7(Previous Recommendation) + β_8(High Risk Condition) + β_9(Awareness of Being Recommended) + β_{10}(Severity) + β_{11}(Susceptibility) + β_{12}(Efficacy) + β_{13}(Safety) + β_{14}(Recommendation Knowledge*Age)

Interaction Assessment

Interaction was assessed with a likelihood ratio test of the interaction variable. The likelihood ratio test was as follows:

$-2\ln L(\text{reduced}) - -2\ln L(\text{full}) = 11211.00 - 11209.20 = 1.8 \sim \chi^2$, 1 degree of freedom

The likelihood ratio test results indicated that the interaction of Recommendation Knowledge and Age was not significant in the model (p = 0.18). The variable was dropped from the model, resulting in a final model without any interaction terms.

The mathematical model at this stage was as follows:

$$\text{Logit } P(\mathbf{X}) = \beta_0 + \beta_1(\text{Recommendation Knowledge}) + \beta_2(\text{Age}) + \beta_3(\text{Sex}) + \beta_4(\text{Education}) + \beta_5(\text{Race/Ethnicity}) + \beta_6(\text{Doctor Visit}) + \beta_7(\text{Previous Recommendation}) + \beta_8(\text{High Risk Condition}) + \beta_9(\text{Awareness of Being Recommended}) + \beta_{10}(\text{Severity}) + \beta_{11}(\text{Susceptibility}) + \beta_{12}(\text{Efficacy}) + \beta_{13}(\text{Safety})$$

Confounding Assessment

To determine if precision of the exposure-outcome prevalence ratio could be improved by deleting a priori confounder variables without materially changing the prevalence ratio estimate, a standard backwards elimination strategy was used. The Wald test p-values of the regression coefficients were compared in the full model at a significance level of 0.05. The variable with the highest p-value was Education (p = 0.75; p = 0.62; p = 0.22). Education was dropped from the model and the model was run again. The prevalence ratio of the main exposure (Recommendation Knowledge) in this model was compared to the prevalence ratio in the full model (1.21 vs. 1.19) and was found to be within 10% of the full model estimate. Therefore, it was determined that Education could be dropped from the model. In the model without Education, the variable with the highest Wald p-value was High-Risk Condition (p=0.43). High Risk Condition was dropped, and the model was run again. The prevalence ratio of the main exposure (Recommendation Knowledge) in this model was compared to the prevalence ratio in the full model (1.20 vs. 1.19) and was found to be within 10% of the full model estimate.

Therefore, it was determined that High Risk Condition could be dropped from the model. In the model without Education or High Risk Condition, the variable with the highest Wald p-value was the variable measuring perception of severity of the flu (Severity; $p = 0.22$). Severity was dropped, and the model was run again. The prevalence ratio of the main exposure (Recommendation Knowledge) in this model was compared to the prevalence ratio in the full model (1.20 vs. 1.19) and was found to be within 10% of the full model estimate. Therefore, it was determined that Severity could be dropped from the model. In the model without Education, High Risk Condition or Severity, all remaining variables had significant Wald p-values. Therefore, no other variables were dropped as confounders. The mathematical model at this point was as follows:

$$\text{Logit } P(\mathbf{X}) = \beta_0 + \beta_1(\text{Recommendation Knowledge}) + \beta_2(\text{Age}) + \beta_3(\text{Sex}) + \beta_4(\text{Race/Ethnicity}) + \beta_5(\text{Doctor Visit}) + \beta_6(\text{Previous Recommendation})) + \beta_7(\text{Awareness of Being Recommended}) + \beta_8(\text{Susceptibility}) + \beta_9(\text{Efficacy}) + \beta_{10}(\text{Safety})$$

The prevalence ratio of Recommendation Knowledge for the above model was 1.20 (95% CI: 1.12, 1.28). The more parsimonious model is often selected in modeling, as it typically produces a more precise estimate of measure of effect of the exposure. However, in this case, the full model (including Education, High Risk Condition and Severity) produces a prevalence ratio estimate of 1.19, with equal precision (95% CI: 1.12, 1.27) to the model without these variables. Additionally, since all covariates in the model were selected because they were known predictors of vaccination receipt, it was decided to keep all covariates in the model.

Final Model 1:

$$\text{Logit } P(\mathbf{X}) = \beta_0 + \beta_1(\text{Recommendation Knowledge}) + \beta_2(\text{Age}) + \beta_3(\text{Sex}) + \beta_4(\text{Education}) + \beta_5(\text{Race/Ethnicity}) + \beta_6(\text{Doctor Visit}) + \beta_7(\text{Previous Recommendation}) + \beta_8(\text{High Risk Condition}) + \beta_9(\text{Awareness of Being Recommended}) + \beta_{10}(\text{Severity}) + \beta_{11}(\text{Susceptibility}) + \beta_{12}(\text{Efficacy}) + \beta_{13}(\text{Safety})$$

Regression coefficients were calculated for each predictor in the final model. Predictive margins, which estimate the probability of an outcome variable while controlling for all other variables in the model, were used to estimate adjusted vaccination rates for each predictor (11, 57). The adjusted prevalence ratio was reported for the main exposure.

Knowledge of Universal Recommendation as Outcome

An additional logistic regression model was run that treated knowledge of the universal recommendation as an outcome, and all remaining covariates as exposures. The purpose of this model was to determine significant predictors of knowledge of the universal recommendation. Prevalence ratios were reported for each covariate.

Model 2:

$$\text{Logit } P(\mathbf{X}) = \beta_0 + \beta_1(\text{Age}) + \beta_2(\text{Sex}) + \beta_3(\text{Education}) + \beta_4(\text{Race/Ethnicity}) + \beta_5(\text{Doctor Visit}) + \beta_6(\text{Previous Recommendation}) + \beta_7(\text{High Risk Condition}) + \beta_8(\text{Awareness of Being Recommended}) + \beta_9(\text{Severity}) + \beta_{10}(\text{Susceptibility}) + \beta_{11}(\text{Efficacy}) + \beta_{12}(\text{Safety})$$

Unadjusted prevalence ratios and 95% confidence intervals were calculated between each variable and the outcome (Recommendation Knowledge) using PROC MULTILOG in SAS-callable SUDAAN.

Analysis Results

Of the 13,867 people surveyed, two-thirds (9,371) did not know that all individuals over 6 months of age are recommended to receive flu vaccine (Table 1). Individuals who received flu vaccination were significantly more likely to have identified the correct age groups for recommendation than those who did not receive vaccine (42.0% v. 25.7%; $p < 0.0001$). Perception of being in a recommended group was significantly associated with knowledge of the universal recommendation, with 41.6% of those who believe themselves to be in a recommended group correctly identifying the recommendation, compared to 25.5% of those who believe they are not in a recommended group ($p < 0.0001$). Women and individuals with high risk health conditions were more likely to know about the universal recommendation. Individuals who fell into a recommended group before universal recommendation were more likely to correctly name the universal recommendation, compared to those who were not previously recommended.

All knowledge, attitude and belief variables, addressing efficacy, susceptibility, safety, and severity, were significantly associated with knowledge of the universal recommendation (Table 1). People who believed the vaccine to be somewhat or very effective in preventing the flu were significantly more likely to know about the universal recommendation than people who believed the vaccine was not too or not at all effective (34.7% vs. 26.7%; $p = 0.004$). Individuals who felt that their chances of getting the flu if they did not get vaccinated were somewhat or very high were more likely to know about the universal recommendation than individuals who thought their chances were very or somewhat low (40.1% vs. 26.8%; $p < 0.0001$). Believing the flu vaccine was somewhat or very safe was significantly associated with knowing about the universal recommendation, compared to believing the flu vaccine was somewhat or very unsafe (34.4% vs. 25.5%; $p = 0.0003$). Of individuals who believed that their daily activities would be very or somewhat disrupted if one contracted influenza 34.3% knew about the universal recommendation, compared with 25.8% of individuals who believed that their daily activities would be not very or not at all disrupted ($p < 0.0001$). Knowledge of the universal recommendation was not significantly associated with education, age, income, race or provider visit in the last year.

The question that measured knowledge of the universal recommendation asked, "To the best of your knowledge, for which age group is the flu vaccine recommended?" The question had 6 possible responses, each based on a part of a vaccination recommendation. Table 2 presents the groups people thought were recommended for vaccine, by vaccination status. The most common groups that respondents identified as recommended for vaccination were all people over 6 months (universal recommendation) and the response including children under 18 and adults 65 years and older. Of people who reported receiving flu vaccine, 30.5% chose this latter, incorrect option, as compared to 41.9% of unvaccinated people who chose this option.

Of respondents, 45.5% reported receiving a flu vaccine in the 2011-2012 season (Table 3). Vaccination coverage varied significantly within each covariate. Vaccination coverage was significantly higher in those who knew about the universal recommendation (57.2%) compared with those who responded incorrectly to that question (38.9%; $p < 0.0001$). People who perceived themselves to be in a recommended group had twice the rates of vaccination of those who thought they were not recommended (64.3% vs. 28.4%; $p < 0.0001$). Individuals who reported that vaccine was very or somewhat safe were nearly 4 times more likely to report being vaccinated than those who believe it is somewhat or very unsafe (49.3% v. 12.9% vaccinated; $p < 0.0001$). Similarly, people who thought vaccine was “not too or not at all” effective had only 18.2% vaccination coverage, compared to those who believed it was somewhat or very effective (50.5%; $p < 0.0001$).

Predictive margins were used to estimate adjusted self-reported vaccination coverage (Table 3). Controlling for age, sex, education, race/ethnicity, doctor visit, previous recommendation, high risk condition, awareness of being recommended, severity, susceptibility, efficacy, and safety, individuals who knew about the universal recommendation had vaccination coverage of 51.5%, compared with those who did not know about universal recommendation (43.1% vaccinated). Adults over 65 had the highest self-reported vaccination coverage (63.1%), while those who think the vaccine is somewhat or very unsafe had the lowest coverage (31.1%).

Using unadjusted prevalence ratios, we determined that individuals who were aware of the universal recommendation were 1.47 times more likely to report vaccination against influenza than those who did not know about the universal recommendation (Table 4). People more likely to be vaccinated in unadjusted models had high risk health conditions, had visited a healthcare provider, were in group recommended for vaccination before the universal recommendation, or perceived themselves to be recommended for vaccination. Individuals with more knowledge, and positive attitudes and beliefs towards flu vaccination were more likely to report receiving vaccine than those who thought the vaccine was ineffective, unsafe, or thought they were not susceptible to the flu.

In the multivariate model, people who knew about the universal recommendation were significantly more likely to have received flu vaccine than those who did not know (Prevalence Ratio: 1.19, 95% CI 1.12, 1.27), controlling for age, sex, education, race/ethnicity, provider visit, inclusion in recommended group before universal recommendation, high risk health condition, perception of being recommended, severity, susceptibility, efficacy, and safety. Table 5 reports estimated regression coefficients for Model 1 (Table 5).

A second part of the analysis treated knowledge of the universal recommendation as the outcome variable (Table 6). Using unadjusted prevalence ratios, we determined which covariates were independently associated with recommendation knowledge. Women were less likely to know about the universal recommendation than men, in an unadjusted model (PR: 0.81; 95% CI: 0.74, 0.88). Individuals with high risk health conditions were 1.18 times more likely to know about the universal recommendation than those without these conditions (95% CI: 1.08, 1.30). People who were previously recommended for vaccination before the universal recommendation were 1.16 times more likely to correctly identify the groups recommended (PR: 1.16; 95% CI: 1.05, 1.29). In an unadjusted model, people who perceived themselves in a group recommended for vaccination were 1.63 times more likely to know the correct categories for recommended groups (95% CI: 1.48, 1.79). In unadjusted models, believing the vaccine is more effective, safer, believing oneself susceptible to influenza, and believing that influenza is severe are each associated with a greater likelihood of knowing about the universal recommendation.

In the fully adjusted Model 2, which treated recommendation knowledge as the outcome, people who perceived themselves to be in a recommended group were 1.52 times more likely to correctly identify the groups recommended for influenza vaccination (95% CI: 1.36, 1.71) (Table 6). Those who believe that their chances of getting influenza if they do not get a flu shot are very or somewhat high are 1.28 times more likely to know about the universal recommendation (95% CI: 1.16, 1.43). Similarly, those who responded that their daily activities would be somewhat or very disrupted if they got the flu were 1.18 times more likely to know about the universal recommendation (95% CI: 1.00, 1.40). Women were also more likely to correctly name the groups covered by the universal recommendation (PR: 1.16; 95% CI: 1.06, 1.27). Adults over 65 and between 50 and 64 were increasingly less likely to know about the universal recommendation than adults 18-49 years of age (PR=0.82 adults 50-64; PR=0.72 adults 50-64). Education, race/ethnicity, provider visit, efficacy and safety were not significantly associated with knowledge of the recommendation, in this adjusted model.

Discussion

This study demonstrates that people who correctly identified the group recommended for influenza vaccination are more likely to report receiving vaccination than those without knowledge of the universal recommendation. This finding was true in a model controlling for age, sex, education, race/ethnicity, doctor visit, previous recommendation, high risk condition, awareness of being recommended, severity, susceptibility, efficacy, and safety. These results suggest that recommendation knowledge is an important predictor of vaccine receipt. A key purpose of the ACIP universal recommendation was to simplify vaccination recommendations, making it easier for individuals to know that they needed vaccination. A goal of this study was to examine the assumption that clarity and knowledge of vaccination recommendations were important in vaccination receipt. Our results confirm this assumption. Knowledge of the recommendation is positively associated with receipt of vaccination against influenza.

Despite this association between vaccination and knowledge, two-thirds of adults in this study were unable to correctly identify that all individuals over 6 months of age are recommended to receive vaccination against influenza. This lack of knowledge is particularly noticeable in adults who were not covered by the recommendation before 2010. Only 33.3% of adults between 18 and 49 years of age without high-risk conditions or contact with high-risk individuals were able to correctly identify the recommended group. Additionally, this group of newly recommended adults had significantly lower vaccination coverage in 2011-2012 than those who were previously recommended. These data suggest that despite campaigns promoting the fact that everyone is now recommended for an annual flu vaccination, those who are newly recommended do not yet possess knowledge of the recommendation. It is necessary to increase public knowledge of this recommendation, either through targeted communication campaigns, or more direct methods.

In this study, knowledge, attitudes, and beliefs (KABs) were independently associated with knowledge of the universal recommendation. Those who believe that vaccine is very or somewhat safe or very or somewhat effective, those who believe themselves very or somewhat susceptible to influenza, and those who think that their daily activities would be very or somewhat disrupted by influenza were more likely to know which groups were recommended for universal vaccination, and were more likely to be vaccinated themselves. This study is the first to specifically examine KABs and knowledge of the universal recommendation. The specific knowledge of vaccination recommendation is significantly associated with other knowledge, attitudes, and beliefs related to influenza vaccination. As KABs and knowledge of the universal recommendation are all associated independently with receipt of vaccination, efforts to increase knowledge of the recommendation should take into account KABs. Existing KABs can be leveraged in order to increase knowledge of recommendations, and efforts can be made to influence KABs while knowledge is imparted.

In the adjusted model, however, three of the KABs—efficacy, safety, and severity—were no longer significantly associated with recommendation knowledge (Table 5). KABs are known to be associated with vaccination receipt, and vaccination is associated with recommendation knowledge. We expected that the relationship between universal recommendation and KABs would persist in an adjusted model. Although the KABs appear to be independent predictors of recommendation knowledge in the logistic regression model, it is incorrect to say that they behave independently of one another. There is always shared variance between KABs, which causes them to function as a cohort within a model. Therefore, it is unexpected that one KAB variable would remain significant in the model while the others did not.

Several demographic factors typically associated with vaccination were not associated with recommendation knowledge in our study. There was no association between race/ethnicity and knowledge of the universal recommendation, although race/ethnicity was a confounder of the relationship between recommendation knowledge and receipt of vaccination. This result is consistent with Maurer's finding that race/ethnicity was not associated with awareness of being recommended for vaccination (15). Another commonly measured demographic factor, education, was neither associated with knowledge of the universal recommendation nor was a confounder of the relationship between recommendation knowledge and vaccination. In our study, income was not associated with recommendation knowledge in unadjusted analysis.

While knowledge of the universal recommendation was not associated with the above demographic characteristics, vaccination coverage did vary significantly by these variables. We found lower rates of vaccination among Black and Hispanic individuals and individuals with lower income. Education did not show a trend in vaccination coverage, although individuals with college degrees had higher vaccination rates than any other education category. Since vaccination rates varied by these characteristics, but knowledge did not, we can conclude that knowledge of the recommendation was not a significant barrier to racial, income, or education equity in adult flu vaccination. Other studies have demonstrated lower rates of influenza vaccination among Black or Hispanic adults, and those with lower incomes or less education (11, 16, 18, 19, 25, 48, 58). Race/ethnicity, income, and education do not appear to be knowledge factors in our study, but they are certainly vaccination receipt factors. Although the majority of individuals were not aware of the universal recommendation, low levels of awareness do not appear to be subject to the same socioeconomic disparities that affect many other aspects of vaccination.

Perception of being recommended for vaccination was significantly associated with both knowledge of the universal recommendation and receipt of vaccination. Maurer (2012) used perception of recommendation as his outcome variable (15). Our results expand upon his, showing that perception/awareness of being recommended for vaccination is associated with knowing which groups are recommended for vaccination. People who believe themselves recommended for vaccination are more likely to know which groups are recommended for vaccination. If perceiving oneself recommended is associated with knowledge of the recommendation, and knowledge of the recommendation is associated with vaccination, increasing the number of people who believe they are recommended may also increase vaccination. This association adds further support to campaigns emphasizing that everyone, and especially you, should receive influenza vaccination.

Provider visit is a well-known predictor of influenza vaccination; our study also identified this relationship (11, 51, 52, 59). However, we did not find self-reported doctor visit to be associated with knowledge of the universal recommendation. This finding implies that providers did not educate their patients about vaccination during healthcare visits. Provider recommendation is also a documented predictor of vaccination;

individuals who receive a recommendation from a provider to receive a flu vaccine are more likely to obtain vaccination than those who do not receive a provider recommendation (11, 51, 52, 59). Our study also identified this association, but the variable was excluded from analysis due to a high percentage of missing values. Doctors' offices are a common location for adults to receive flu vaccination, a fact that likely contributes to the association between provider visits and receipt of vaccination. Provider visits offer an important opportunity for vaccination and education about influenza. It is possible that healthcare providers have informed patients that the patient needs a flu vaccination, but have not shared information about the recommendation itself. It may be advisable to reach out to healthcare providers to encourage them to educate patients about the universal recommendation.

Another, more concerning hypothesis, is that providers are not themselves aware of the universal recommendation. Healthcare providers are essential partners in adult influenza immunization; it is important that they know about the universal recommendation and pass this information onto patients. An area for further study is provider knowledge of the universal recommendation. Such a study could provide important insight into potential gaps in the immunization knowledge delivery system, and further identify groups that need to be targeted for information dissemination. Based on the results of our study, healthcare providers can be identified as target for universal recommendation awareness campaigns. Given that over 70% of survey respondents visited a healthcare provider between July 2011 and March 2012, we assert that healthcare visits present an essential opportunity for the distribution of both vaccination and knowledge. Partnering with providers to increase their knowledge is an important strategy.

We must consider whether knowledge of the specifics of the universal recommendation is as critical as an individual's knowledge of being personally recommended for flu vaccination. It could be argued that future communications campaigns should focus on the message that "you" need a flu shot, rather than "who" needs a flu shot. Although knowledge of the specific recommendation may not be as key to programmatic and communications planning as the awareness of being recommended, studying how vaccination recommendations have reached the public consciousness remains useful. ACIP passed the universal recommendation after careful consideration and planning. It is important to know the outcomes of this recommendation concerning both vaccination coverage and recommendation knowledge. Seasonal estimates of influenza vaccination levels in the population track the impact of the universal recommendation on vaccination coverage, but studies are necessary to determine whether people know about the change in recommendation.

Our findings can help to determine whether existing awareness campaigns about the universal recommendation have succeeded in informing the public of the recommendation. With information on the characteristics of groups that do and do not know about the universal recommendation, awareness campaigns can be further refined to target groups with lower knowledge of the recommendation. For example, a communications campaign could specifically reach out to adult men, who were significantly less likely to correctly identify the universal recommendation. This research on knowledge and vaccination can inform campaigns and ensure people receive the right message: influenza vaccination is for everyone.

The Healthy People 2020 objective to increase annual vaccination against influenza among adults to 80% is a clear and quantifiable metric (5). However, given the 2011-2012 influenza vaccination coverage of 38.8% among adults over 18 years, progress remains to be made in order to meet that goal (6). To increase coverage of influenza vaccination, a shift in public action and public awareness must occur. As knowledge is associated with vaccination, and knowledge levels are low, there remains a need to increase knowledge of influenza vaccination recommendations among the general public. Communications campaigns can seek to raise awareness and knowledge of the recommendations. Such strategies may increase vaccination coverage, but other factors contribute to low rates of influenza vaccination among adults. Neither communications campaigns nor immunization programs alone can raise influenza vaccination coverage, but must collaborate to increase both knowledge of the universal recommendation and the receipt of vaccination.

Limitations

This study is subject to several limitations. First, selection bias may have resulted from the exclusion of households without any sort of telephone. The nature of random-digit-dialed telephone surveys causes this limitation. It is possible that those without telephones have different demographic characteristics, and possibly different knowledge and vaccination coverage than those with landlines or cell phones. The inclusion of cell-phone-exclusive households in the sample is intended to correct for bias from sampling only those with landlines, but does not address potential bias from exclusion of households lacking cellular phones or landlines.

A second limitation is the low CASRO response rate, particularly among cell phone users (31.4% for landlines and 18.3% for cell phones). This rate could lead to non-response bias, even after weighting of the results (18). Non-respondents may have answered questions differently than respondents (60). The purpose of the National Flu Survey was to obtain a rapid estimate of end-of-season flu vaccination coverage; therefore, only a month is spent collecting data. This time-frame does not allow for the multiple attempts to contact participants, as is the case with the National Immunization Survey (CASRO response rates of 51.8%–57.3% for landline and 19.9%–30.3% for cellular telephones in 2012). Although the CASRO response rate is low in the National Flu Survey, the results provide a rapid picture of seasonal flu vaccination and are comparable to other gold standard surveys.

High rates of missing values in certain variables may lead to under- or over-estimation of results, a third limitation of this study. Imputed variables addressed some of this problem, but income and provider recommendation retained a large number of missing responses.

Another limitation of this study is that vaccination status was self-reported, and not confirmed with medical records. However, several studies validate the use of self-reported influenza vaccination among adults (61-63). Our study was conducted in March of 2012, and referred to events since July 1, 2011. Therefore, it also may be subject to recall bias; as most individuals receive influenza immunizations in October and November (64).

The variable Previous Recommendation may be subject to misclassification bias. This variable combines the groups that were recommended to receive vaccination in the season before the universal recommendation: high-risk health condition, household contact with person with chronic disease, close contact with an infant under 6 months, health care workers with direct patient contact, and those over 50 years of age. It is possible that a person who fit into one of these categories at the time of the survey would not have been included in a recommended group in previous years. The variable may not be an accurate reflection of respondents who were actually recommended to receive vaccination before the universal recommendation.

There is an important distinction between someone knowing they personally are recommended for vaccination, and knowing the groups that are recommended. Our main exposure variable is knowledge of recommended groups; respondents were asked to identify which groups were recommended for vaccination out of 6 possible choices. It is quite possible that many people knew that they personally needed a flu shot, but did not know the specifics of the recommendation. This may especially be true for those who have long been recommended for vaccination; for example, a 70-year-old could have been receiving influenza vaccination for 20 years, and would have little reason to know about the new recommendation. Indeed, in Model 2, where knowledge of the universal recommendation was the outcome, adults 50-64 and 65 and over were significantly less likely to know about the universal recommendation than adults 18-49 years of age. Our study may be limited by the distinction between knowing a specific recommendation and knowing the part of a recommendation that pertains to you. The addition of a variable that identifies whether a respondent believes that they are in a group recommended to receive flu vaccination helped to control for confounding from this issue.

Another limitation is that we are unable to assess causation between knowledge of the universal recommendation and vaccination behavior. This limitation is true in all cross-sectional studies. Additionally, we cannot conclude directionality or temporal relationships knowledge of the universal recommendation and vaccination behavior, nor directionality between any of the knowledge, attitudes or beliefs variables. We can say that individuals who believe in the efficacy of the flu vaccine are more likely to be vaccinated, but we do not know if a belief in efficacy leads one to receive vaccine, or if receiving vaccine affects one's beliefs regarding vaccination. Fortunately, the identification of an association will still be useful, even in the absence of a causal relationship. Despite the limitations of this research, our findings contribute to the emerging body of work examining influenza vaccination in the years following the universal recommendation.

References

1. Cox NJ, Subbarao K. Influenza. Lancet 1999;354(9186):1277-82.

2. Fiore AE, Uyeki TM, Broder K, Finelli L, Euler GL, Singleton JA, et al. Prevention and control of influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2010. MMWR Recomm Rep 2010;59(RR-8):1-62.

3. Schwartz B, Hinman A, Abramson J, Strikas RA, Allred N, Uyeki T, et al. Universal influenza vaccination in the United States: are we ready? Report of a meeting. J Infect Dis 2006;194 Suppl 2:S147-54.

4. Abramson JS, Neuzil KM, Tamblyn SE. Annual universal influenza vaccination: ready or not? Clin Infect Dis 2006;42(1):132-5.

5. U.S. Department of Health and Human Services. Healthy People 2020. In: Promotion OoDPaH, editor. Washington, DC.

6. Centers for Disease Control and Prevention. Flu Vaccination Coverage, United States, 2011-2012 Flu Season. In; 2012.

7. Centers for Disease Control and Prevention. Final estimates for 2009–10 Seasonal Influenza and Influenza A (H1N1) 2009 Monovalent Vaccination Coverage – United States, August 2009 through May, 2010. In: Seasonal Influenza (Flu); 2011.

8. Centers for Disease Control and Prevention. Flu Vaccination Coverage, United States, 2010-2011 Flu Season. In; 2011.

9. Hollmeyer HG, Hayden F, Poland G, Buchholz U. Influenza vaccination of health care workers in hospitals--a review of studies on attitudes and predictors. Vaccine 2009;27(30):3935-44.

10. Galarce EM, Minsky S, Viswanath K. Socioeconomic status, demographics, beliefs and A(H1N1) vaccine uptake in the United States. Vaccine 2011;29(32):5284-9.

11. Santibanez TA, Mootrey GT, Euler GL, Janssen AP. Behavior and beliefs about influenza vaccine among adults aged 50-64 years. Am J Health Behav 2010;34(1):77-89.

12. Drees M, Tambourelli B, Denstman A, Zhang W, Zent R, McGraw P, et al. Sustained high influenza vaccination rates and decreased safety concerns among pregnant women during the 2010-2011 influenza season. Vaccine 2013;31(2):362-6.

13. Prematunge C, Corace K, McCarthy A, Nair RC, Pugsley R, Garber G. Factors influencing pandemic influenza vaccination of healthcare workers--a systematic review. Vaccine 2012;30(32):4733-43.

14. Taddio A, Ipp M, Thivakaran S, Jamal A, Parikh C, Smart S, et al. Survey of the prevalence of immunization non-compliance due to needle fears in children and adults. Vaccine 2012;30(32):4807-12.

15. Maurer J, Harris KM, Parker AM. Who knew? Awareness of being recommended for influenza vaccination among U.S. adults. Influenza Other Respi Viruses 2012;6(4):284-90.

16. de Perio MA, Wiegand DM, Evans SM. Low influenza vaccination rates among child care workers in the United States: assessing knowledge, attitudes, and behaviors. J Community Health 2012;37(2):272-81.

17. Redelings MD, Piron J, Smith LV, Chan A, Heinzerling J, Sanchez KM, et al. Knowledge, attitudes, and beliefs about seasonal influenza and H1N1 vaccinations in a low-income, public health clinic population. Vaccine 2012;30(2):454-8.

18. Santibanez TA, Singleton JA, Santibanez SS, Wortley P, Bell BP. Socio-demographic differences in opinions about 2009 pandemic influenza A (H1N1) and seasonal influenza vaccination and disease among adults during the 2009-2010 influenza season. Influenza Other Respi Viruses 2012.

19. Wooten KG, Wortley PM, Singleton JA, Euler GL. Perceptions matter: Beliefs about influenza vaccine and vaccination behavior among elderly white, black and Hispanic Americans. Vaccine 2012;30(48):6927-34.

20. Zhang J, While AE, Norman IJ. Seasonal influenza vaccination knowledge, risk perception, health beliefs and vaccination behaviours of nurses. Epidemiol Infect 2012;140(9):1569-77.

21. Riddiough MA, Willems JS, Sanders CR, Kemp K. Factors affecting the use of vaccines: considerations for immunization program planners. Public Health Rep 1981;96(6):528-35.

22. Frew PM, Painter JE, Hixson B, Kulb C, Moore K, del Rio C, et al. Factors mediating seasonal and influenza A (H1N1) vaccine acceptance among ethnically diverse populations in the urban south. Vaccine 2012;30(28):4200-8.

23. Thompson MG, Gaglani MJ, Naleway A, Ball S, Henkle EM, Sokolow LZ, et al. The expected emotional benefits of influenza vaccination strongly affect pre-season intentions and subsequent vaccination among healthcare personnel. Vaccine 2012;30(24):3557-65.

24. Lindley MC, Wortley PM, Winston CA, Bardenheier BH. The role of attitudes in understanding disparities in adult influenza vaccination. Am J Prev Med 2006;31(4):281-5.

25. Cohen B, Ferng YH, Wong-McLoughlin J, Jia H, Morse SS, Larson EL. Predictors of flu vaccination among urban Hispanic children and adults. J Epidemiol Community Health 2012;66(3):204-9.

26. Fiore AE, Shay DK, Broder K, Iskander JK, Uyeki TM, Mootrey G, et al. Prevention and control of influenza: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2008. MMWR Recomm Rep 2008;57(RR-7):1-60.

27. Fiore AE, Shay DK, Broder K, Iskander JK, Uyeki TM, Mootrey G, et al. Prevention and control of seasonal influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2009. MMWR Recomm Rep 2009;58(RR-8):1-52.

28. Fiore AE, Epperson S, Perrotta D, Bernstein H, Neuzil K. Expanding the recommendations for annual influenza vaccination to school-age children in the United States. Pediatrics 2012;129 Suppl 2:S54-62.

29. Neuzil KM, Fiore AE, Schieber RA. Evolution of the pediatric influenza vaccination program in the United States. Pediatrics 2012;129 Suppl 2:S51-3.

30. Bridges CB, Fukuda K, Cox NJ, Singleton JA, Advisory Committee on Immunization P. Prevention and control of influenza. Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 2001;50(RR-4):1-44.

31. Centers for Disease Control and Prevention. Updated recommendations from the Advisory Committee on Immunization Practices in response to delays in supply of influenza vaccine for the 2000-01 season. MMWR Morb Mortal Wkly Rep 2000;49(39):888-92.

32. Bridges CB, Fukuda K, Uyeki TM, Cox NJ, Singleton JA, Centers for Disease C, et al. Prevention and control of influenza. Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 2002;51(RR-3):1-31.

33. Harper SA, Fukuda K, Uyeki TM, Cox NJ, Bridges CB, Centers for Disease C, et al. Prevention and control of influenza: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 2004;53(RR-6):1-40.

34. Harper SA, Fukuda K, Uyeki TM, Cox NJ, Bridges CB, Advisory Committee on Immunization Practices CfDC, et al. Prevention and control of influenza. Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 2005;54(RR-8):1-40.

35. Centers for Disease Control and Prevention. Estimated influenza vaccination coeverage among childrne and adults--United States, September 1 2004-January 31, 2005. MMWR Morbidity and Mortality Weekly Report 2005;53:304-7.

36. Nichol KL. Cost Benefit Analysis of Influenza Vaccination of Healthy Adults. In: Universal Vaccination against Influeza: Are We Ready?; 2005; Atlanta, Georgia; 2005.

37. Nichol KL, Mallon KP, Mendelman PM. Cost benefit of influenza vaccination in healthy, working adults: an economic analysis based on the results of a clinical trial of trivalent live attenuated influenza virus vaccine. Vaccine 2003;21(17-18):2207-17.

38. Nichol KL. Cost-benefit analysis of a strategy to vaccinate healthy working adults against influenza. Arch Intern Med 2001;161(5):749-59.

39. Poland GA. The Long Road to a Universal Influenza Immunization Recommendation: What Took So Long? In: National Influenza Vaccine Summit: Increasing coverage for the 2010-2011 season: Pandemic, perceptions, progress, prevention and perspectives Scottsdale, AZ; 2010.

40. Poland GA, Morse D. Improving the public health: the U.S. recommendation for universal influenza immunization. Vaccine 2010;28(16):2799-800.

41. 2009 World Population Data Sheet. In: Population Reference Bureau; 2009.

42. Centers for Disease Control and Prevention. Swine influenza A (H1N1) infection in two children--Southern California, March-April 2009. MMWR Morb Mortal Wkly Rep 2009;58(15):400-2.

43. Centers for Disease Control and Prevention. Use of influenza A (H1N1) 2009 monovalent vaccine: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2009. MMWR Recomm Rep 2009;58(RR-10):1-8.

44. Centers for Disease Control and Prevention. The 2009 H1N1 Pandemic: Summary Highlights, April 2009-April 2010. In: H1N1 Flu; 2010.

45. Centers for Disease Control and Prevention. Interim results: state-specific influenza A (H1N1) 2009 monovalent vaccination coverage - United States, October 2009-January 2010. MMWR Morb Mortal Wkly Rep 2010;59(12):363-8.

46. Centers for Disease Control and Prevention. Update: influenza activity--United States, August 30, 2009--March 27, 2010, and compositio of the 2010--22 influenza vaccine. Morbidity and Mortality Weekly Report 2010;59:423-30.

47. Centers for Disease Control and Prevention. Hospitalized patients with novel influenza A (H1N1) virus infection - California, April-May, 2009. MMWR Morb Mortal Wkly Rep 2009;58(19):536-41.

48. Hebert PL, Frick KD, Kane RL, McBean AM. The causes of racial and ethnic differences in influenza vaccination rates among elderly Medicare beneficiaries. Health Serv Res 2005;40(2):517-37.

49. Maurer J, Uscher-Pines L, Harris KM. Awareness of government seasonal and 2009 H1N1 influenza vaccination recommendations among targeted US adults: the role of provider interactions. Am J Infect Control 2010;38(6):489-90.

50. Centers for Disease Control and Prevention. 10 Years of Flu Communication Research at CDC; 2012.

51. Johnson DR, Nichol KL, Lipczynski K. Barriers to adult immunization. Am J Med 2008;121(7 Suppl 2):S28-35.

52. Vlahov D, Bond KT, Jones KC, Ompad DC. Factors associated with differential uptake of seasonal influenza immunizations among underserved communities during the 2009-2010 influenza season. J Community Health 2012;37(2):282-7.

53. Centers for Disease Control and Prevention. Adult Immunization: Knowledge, Attitudes, and Practices -- DeKalb and Fulton Counties, Georgia, 1988 Morbidity and Mortality Weekly Report 1988;37(43):657-661.

54. Centers for Disease Control and Prevention. Prevention and control of influenza: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 1997;46(RR-9):1-25.

55. Bieler GS, Brown GG, Williams RL, Brogan DJ. Estimating model-adjusted risks, risk differences, and risk ratios from complex survey data. Am J Epidemiol 2010;171(5):618-23.

56. Delaney KP, Zack, M., Singleton, J., Satterwhite, C.,. Collinearity macro (SAS). In: Rollins School of Public Health at Emory University; 2013.

57. Nadel MR, Shapiro JA, Klabunde CN, Seeff LC, Uhler R, Smith RA, et al. A national survey of primary care physicians' methods for screening for fecal occult blood. Ann Intern Med 2005;142(2):86-94.

58. Chen JY, Fox SA, Cantrell CH, Stockdale SE, Kagawa-Singer M. Health disparities and prevention: racial/ethnic barriers to flu vaccinations. J Community Health 2007;32(1):5-20.

59. Zimmerman RK, Nowalk MP, Santibanez TA, Jewell IK, Raymond M. Shortage of influenza vaccine in 2000-2001: did it change patient beliefs? Am J Prev Med 2003;24(4):349-53.

60. Hurley LP, Wortley P, Allison MA, O'Leary S, Daley MF, Babbel C, et al. Seasonal influenza vaccination in adults: practice and attitudes about collaborative delivery with community vaccinators. Vaccine 2011;29(47):8649-55.

61. Mac Donald R, Baken L, Nelson A, Nichol KL. Validation of self-report of influenza and pneumococcal vaccination status in elderly outpatients. Am J Prev Med 1999;16(3):173-7.

62. Skull SA, Andrews RM, Byrnes GB, Kelly HA, Nolan TM, Brown GV, et al. Validity of self-reported influenza and pneumococcal vaccination status among a cohort of hospitalized elderly inpatients. Vaccine 2007;25(25):4775-83.

63. Zimmerman RK, Raymund M, Janosky JE, Nowalk MP, Fine MJ. Sensitivity and specificity of patient self-report of influenza and pneumococcal polysaccharide vaccinations among elderly outpatients in diverse patient care strata. Vaccine 2003;21(13-14):1486-91.

64. Kraut A, Graff L, McLean D. Behavioral change with influenza vaccination: factors influencing increased uptake of the pandemic H1N1 versus seasonal influenza vaccine in health care personnel. Vaccine 2011;29(46):8357-63.

Tables

Table 1. Knowledge of the Universal Recommendation for Influenza Vaccination Among Adults by Demographic Characteristics, National Flu Survey, March 2012

	Total (n=13867)		Know about Universal Recommendation (n=4496)[a]		Don't Know about Universal Recommendation (n=9371)		
	No.	**%**	**No.**	**%**	**No.**	**%**	**p-value[b]**
Total Sample	13867	100	4496	32.4	9371	67.6	
Received Flu Vaccine, 2011-2012							
Yes	7179	45.0	2825	42.0	4354	58.0	< 0.0001
No	6657	55.0	1661	25.7	4996	74.3	
Sex							
Male	7055	50.9	2097	29.6	4958	70.4	< 0.0001
Female	6812	49.1	2399	36.6	4413	63.4	
Education							
<12 years	1096	9.8	366	35.8	730	64.2	0.52
12 years	2502	22.3	823	31.1	1679	68.9	
Some college	3419	29.2	1108	32.9	2311	67.1	
College graduate	5884	38.6	1885	33.2	3999	66.8	
Age[c]							
18-49 years	5437	59.8	1755	33.3	3682	66.7	0.91
50-64 years	4322	24.5	1407	32.7	2915	67.3	
65+ years	4108	15.8	1334	32.6	2774	67.4	
Income							
> $150,000	1673	9.6	518	36.5	1077	63.5	0.28
$75,000 - $150,000	2957	19.6	898	33.5	1910	66.4	
< $75,000, Above Poverty	4306	28.0	1311	31.7	2726	68.3	
Below Poverty	1777	14.8	534	34.8	1091	65.2	
Missing	4917	28.0					

Table 1. Knowledge of the Universal Recommendation for Influenza Vaccination Among Adults by Demographic Characteristics, National Flu Survey, March 2012

	Total (n=13867)		Know about Universal Recommendation (n=4496)[a]		Don't Know about Universal Recommendation (n=9371)		
	No.	%	No.	%	No.	%	p-value[b]
Ethnicity/Race							
White, Non-Hispanic	9751	67.0	3189	33.2	6562	65.1	0.86
Hispanic	1435	14.0	445	33.7	990	61.2	
Black, Non-Hispanic	1623	12.1	541	32.8	1082	62.0	
Asian, Non-Hispanic	630	4.4	183	31.2	447	62.5	
Other or Multi-Racial, Non-Hispanic	428	2.4	138	29.0	290	62.2	
Provider visit since July 1, 2011							
Yes	12044	72.8	3563	33.9	7138	66.1	0.08
No	3529	27.2	923	30.8	2211	69.2	
High risk health condition[d]							
Yes	4555	28.9	1616	37.1	2939	62.9	0.0006
No	8702	71.1	2679	31.4	6023	68.6	
Recommended before universal recommendation[e]							
Yes	10300	61.5	3453	34.9	6847	65.1	0.003
No	3567	38.5	1043	30.0	2524	70.0	
Perceives self in group currently recommended for vaccine							
Yes	7212	46.7	2773	41.6	4439	58.4	< 0.0001
No	6096	53.3	1538	25.5	4558	74.5	
How effective do you think the flu vaccine is in preventing the flu?							
Somewhat or very effective	11555	87.2	3933	34.7	7622	65.3	0.0004
Not too or not at all effective	1553	12.8	362	26.7	1191	73.3	
If you do not get a flu vaccine, what are your changes of getting the flu?							
Very or somewhat high	6476	46.6	2499	40.1	3977	59.9	< 0.0001
Very or somewhat low	7037	53.4	1873	26.8	5164	73.2	

Table 1. Knowledge of the Universal Recommendation for Influenza Vaccination Among Adults by Demographic Characteristics, National Flu Survey, March 2012

	Total (n=13867)		Know about Universal Recommendation (n=4496)[a]		Don't Know about Universal Recommendation (n=9371)		
	No.	%	No.	%	No.	%	p-value[b]
How safe do you think the flu vaccine is?							
Very or somewhat safe	12223	89.6	4090	34.4	8133	65.7	0.0003
Very or somewhat unsafe	1305	10.4	308	25.5	997	74.5	
How affected would your daily activities be if you got the flu?							
Very or somewhat disrupted	11720	84.6	3903	34.3	7817	65.7	< 0.0001
Not very or not at all disrupted	2001	15.4	537	25.8	1464	74.2	

[a] Correctly identified the group recommended for the universal recommendation (For All People 6 Months of Age and Older) from the following choices: For Children under 6 Months of Age; For All People 6 Months of Age and Older; For Children 6 Months Through 18 Years and Adults Age 65 and Older; For Everyone Over 18 years of Age; For Children Under 18 Years of Age and Adults Age 65 and Older; and For People 65 and Older.
[b] Wald Chi-squared analysis, $\alpha=0.05$.
[c] Age categories based on ACIP recommendations for influenza vaccination
[d] These health conditions place an individual at increased risk of complications from influenza and include asthma, diabetes, heart disease, liver conditions, weakened immune systems, lung conditions other than asthma, kidney conditions, obesity, sickle cell anemia or other anemia, and neurological or neuromuscular conditions,
[e] Combines variables measuring respondent high-risk health condition, household contact with persons with high-risk health conditions, close contact with an infant under 6 months, and health care workers with direct patient contact, as well as individuals over 50 years of age.

Table 2. Knowledge regarding groups recommended to receive influenza vaccination by vaccination status in adults over 18 years of age, National Flu Survey, March 2012.

	Total (n=15094)		For Children under 6 Months of Age		For All People 6 Months of Age and Older		For Children 6 Months Through 18 Years, and Adults Age 65 and Older		For Everyone Over 18 years of Age		For Children Under 18 Years of Age and Adults Age 65 and Older		For People 65 and Older	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Total Sample	9384	100	130	1.1	4496	33.0	388	4.1	1599	11.0	4888	36.7	2366	14.1
Received Flu Vaccine														
Yes	7179	45.0	52	0.5	2825	42.0	130	2.5	890	11.8	2113	30.5	1169	12.7
No	6657	55.0	78	1.7	1661	25.7	255	5.3	705	10.4	2768	41.9	1190	15.1

Table 3. Adjusted and unadjusted influenza vaccination coverage by demographic characteristic among adults over 18 years, 2011-2012 flu season, March 2012 National Flu Survey

	Received Flu Vaccine 2011-2012[a] (n=8,185)			**Predictive Marginal (Adjusted Vaccination Rate)[b]**	
	No.	%	p-value*	%	95%CI
Total Sample	8,185	45.5			
Know about universal recommendation					
Yes	2,825	57.2	< 0.0001	51.5	48.7, 54.2
No	4,354	38.9		43.1	41.1, 45.2
Sex					
Male	3,612	43.0	0.01	47.6	45.4, 49.8
Female	3,567	47.0		44.4	42.1, 46.6
Education					
<12 years	545	43.0	< 0.0001	45.3	40.4, 50.3
12 years	1,268	42.1		44.3	40.9, 47.8
Some college	1,654	40.4		43.9	41.1, 46.8
College graduate	3,273	49.9		48.6	46.3, 51.0
Age[c]					
18-49 years	1,978	35.5	< 0.0001	41.7	39.0, 44.4
50-64 years	2,218	50.9		46.5	43.4, 49.6
65+ years	2,983	71.7		63.1	59.6, 66.3
Income					
> $150,000	874	50.3	0.002	Removed from Model	
$75,000 - $150,000	1,455	46.6			
< $75,000, Above Poverty	2,079	42.1			
Below Poverty	738	39.1			
Ethnicity/Race					
Hispanic	606	38.3	< 0.0001	45.1	40.6, 49.8
Black, Non-Hispanic	740	34.7		40.3	36.0, 44.8
White, Non-Hispanic	5,348	48.6		47.0	45.0, 48.9
Asian, Non-Hispanic	297	42.0		48.0	42.2, 54.0
Other or Multi-Racial, Non-Hispanic	188	38.7		50.9	43.2, 58.6

Table 3, continued. Adjusted and unadjusted influenza vaccination coverage by demographic characteristic among adults over 18 years, 2011-2012 flu season, March 2012 National Flu Survey

	Received Flu Vaccine 2011-2012[a] (n=8,185)			Predictive Marginal (Adjusted Vaccination Rate)[b]	
	No.	%	p-value*	%	95%CI
Provider visit since July 1, 2011					
Yes	6,104	50.9	< 0.0001	48.3	46.3, 50.3
No	1,058	29.0		39.8	36.8, 43.0
High risk health condition[d]					
Yes	2,938	57.1	< 0.0001	45.3	42.3, 48.2
No	3,942	39.9		46.3	44.3, 48.4
Recommended before universal recommendation[e]					
Yes	6,078	54.4	< 0.0001	48.1	45.5, 50.8
No	1,101	29.9		42.3	38.8, 45.8
Perceives self in group currently recommended for vaccine					
Yes	4,928	64.3	< 0.0001	54.7	52.1, 57.3
No	2,009	28.4		37.8	35.5, 40.2
How effective do you think the flu vaccine is in preventing the flu?					
Somewhat or very effective	6,654	50.5	< 0.0001	47.2	45.4, 49.0
Not too or not at all effective	284	18.2		34.1	29.0, 39.7
If you do not get a flu vaccine, what are your chances of getting the flu?					
Very or somewhat high	4,832	67.9	< 0.0001	60.9	58.2, 63.5
Very or somewhat low	2,102	24.3		31.1	28.9, 33.3
How safe do you think the flu vaccine is?					
Very or somewhat safe	6,905	49.3	< 0.0001	47.4	45.6, 49.2
Very or somewhat unsafe	172	12.9		28.6	23.4, 34.5
How affected would your daily activities be if you got the flu?					
Very or somewhat disrupted	6,303	47.2	< 0.0001	46.5	44.7, 48.3
Not very or not at all disrupted	793	32.8		42.7	38.7, 47.0

[a] Estimates weighted based on population totals, adjusting for sampling probability within a household, landline and cell-phone sampling issues, and person and household non-response

[b] In a model with vaccination as the outcome, knowledge of the universal recommendation as the exposure, controlling for age, sex, education, race/ethnicity, doctor visit, previous recommendation, high risk condition, awareness of being recommended, severity, susceptibility, efficacy, and safety

[c] Age categories based on ACIP recommendations for influenza vaccination

[d] These health conditions place an individual at increased risk of complications from influenza and include asthma, diabetes, heart disease, liver conditions, weakened immune systems, lung conditions other than asthma, kidney conditions, obesity, sickle cell anemia or other anemia, and neurological or neuromuscular conditions,

[e] Combines variables measuring respondent high-risk health condition, household contact with persons with high-risk health conditions, close contact with an infant under 6 months, and health care workers with direct patient contact, as well as individuals over 50 years of age.

Table 4. Association of receipt of flu vaccination with knowledge of the universal recommendation, demographic characteristics and belief variables, National Flu Survey, March 2012

	Unadjusted Prevalence Ratio for Vaccination Receipt[a]		Adjusted Prevalence Ratio for Vaccination Receipt[b]	
	PR	95%CI	PR	95%CI
Knowledge of Universal Recommendation				
Yes	1.47	1.37, 1.57	1.19	1.12, 1.27
No	ref		ref	
Sex				
Female	ref		ref	
Male	0.92	0.85, 0.98	1.07	1.01, 1.14
Education				
<12 years	ref		ref	
12 years	0.98	0.84, 1.14	0.98	0.86, 1.12
Some college	0.94	0.81, 1.09	0.97	0.86, 1.10
College graduate	1.16	1.01, 1.33	1.07	0.95, 1.21
Age[c]				
18-49 years	ref		ref	
50-64 years	1.44	1.32, 1.56	1.12	1.01, 1.24
65+ years	2.02	1.88, 2.17	1.51	1.38, 1.66
Ethnicity/Race				
White, Non-Hispanic	ref		ref	
Hispanic	0.79	0.69, 0.90	0.96	0.86, 1.07
Black, Non-Hispanic	0.71	0.62, 0.82	0.86	0.77, 0.96
Asian, Non-Hispanic	0.86	0.74, 1.02	1.02	0.90, 1.16
Other or Multi-Racial, Non-Hispanic	0.79	0.62, 1.02	1.08	0.93, 1.27

Table 4, continued. Association of receipt of flu vaccination with knowledge of the universal recommendation, demographic characteristics and belief variables, National Flu Survey, March 2012

	Unadjusted Prevalence Ratio for Vaccination Receipt [a]		Adjusted Prevalence Ratio for Vaccination Receipt [b]	
	PR	95%CI	PR	95%CI
Provider visit since July 1, 2011				
Yes	1.76	1.58, 1.95	1.21	1.11, 1.32
No	ref		ref	
High risk health condition [d]				
Yes	1.43	1.34, 1.53	0.98	0.90, 1.06
No	ref		ref	
Recommended before universal recommendation [e]				
Yes	1.82	1.65, 2.00	1.14	1.01, 1.28
No	ref		ref	
Perceives self in group currently recommended for vaccine				
Yes	2.26	2.09, 2.45	1.45	1.34, 1.57
No	ref		ref	
How effective do you think the flu vaccine is in preventing the flu?				
Somewhat or very effective	2.77	2.28, 3.38	1.38	1.18, 1.62
Not too or not at all effective	ref		ref	
If you do not get a flu shot what are your chances of getting the flu?				
Very or somewhat high	2.79	2.58, 3.02	1.96	1.80, 2.13
Very or somewhat low	ref		ref	
How safe do you think the flu vaccine is?				
Very or somewhat safe	3.83	2.94, 4.99	1.66	1.36, 2.02
Very or somewhat unsafe	ref		ref	
How affected would your daily activities be if you got the flu?				
Very or somewhat disrupted	1.44	1.26, 1.64	1.09	0.99, 1.20
Not very or not at all disrupted	ref		ref	

[a] Unadjusted model with vaccination as the outcome
[b] In a logistic regression model of the effect of knowledge of universal recommendation on vaccination, controlling for age, sex, education, race/ethnicity, doctor visit, previous recommendation, high risk condition, awareness of being recommended, severity, susceptibility, efficacy, and safety
[c] Age categories based on ACIP recommendations for influenza vaccination
[d] These health conditions place an individual at increased risk of complications from influenza and include asthma, diabetes, heart disease, liver conditions, weakened immune systems, lung conditions other than asthma, kidney conditions, obesity, sickle cell anemia or other anemia, and neurological or neuromuscular conditions,
[e] Combines variables measuring respondent high-risk health condition, household contact with persons with high-risk health conditions, close contact with an infant under 6 months, and health care workers with direct patient contact, as well as individuals over 50 years of age.

Table 5. Association of knowledge of the universal recommendation with receipt of influenza vaccination, estimated coefficients, National Flu Survey, March 2012[a]

	Model Coefficient Estimates	
	β	SE
Intercept	-4.32	0.32
Recommendation Knowledge	0.50	0.10
Sex	-0.20	0.09
Education		
<12 years	ref	ref
12 years	-0.06	0.19
Some college	-0.08	0.17
College graduate	0.20	0.17
Age[b]		
18-49 years	ref	ref
50-64 years	0.28	0.13
65+ years	1.25	0.14
Ethnicity/Race		
White, Non-Hispanic	ref	ref
Hispanic	-0.11	0.15
Black, Non-Hispanic	-0.41	0.15
Asian, Non-Hispanic	0.07	0.19
Other or Multi-Racial, Non-Hispanic	0.24	0.24
Provider visit	0.51	0.11
High risk health condition[c]	-0.07	0.11
Previous recommendation[d]	0.35	0.15
Perceived recommendation	0.95	0.09
Efficacy	0.8	0.18
Susceptibility	1.58	0.09
Safety	1.17	0.20
Severity	0.23	0.13

[a] In a logistic regression model of the effect of knowledge of universal recommendation on vaccination, controlling for age, sex, education, race/ethnicity, doctor visit, previous recommendation, high risk condition, awareness of being recommended, severity, susceptibility, efficacy, and safety

[b] Age categories based on ACIP recommendations for influenza vaccination

[c] These health conditions place an individual at increased risk of complications from influenza and include asthma, diabetes, heart disease, liver conditions, weakened immune systems, lung conditions other than asthma, kidney conditions, obesity, sickle cell anemia or other anemia, and neurological or neuromuscular conditions,

[d] Combines variables measuring respondent high-risk health condition, household contact with persons with high-risk health conditions, close contact with an infant under 6 months, and health care workers with direct patient contact, as well as individuals over 50 years of age.

Table 6. Variables associated with knowledge of the universal recommendation, adjusted and unadjusted estimates, by demographic characteristics and knowledge, attitude, and belief variables, National Flu Survey, March 2012

	Unadjusted Prevalence Ratio for Knowledge of Recommendation[a]		**Adjusted Prevalence Ratio for Knowledge of Recommendation**[b]	
	PR	95%CI	PR	95%CI
Sex				
Male	ref		ref	
Female	0.81	0.74, 0.88	1.16	1.06, 1.27
Education				
<12 years	ref		ref	
12 years	0.87	0.72, 1.05	0.88	0.73, 1.07
Some college	0.92	0.77, 1.10	0.90	0.75, 1.08
College graduate	0.93	0.78, 1.10	0.88	0.73, 1.05
Age[c]				
18-49 years	ref		ref	
50-64 years	0.98	0.89, 1.09	0.82	0.72, 0.94
65+ years	0.98	0.88, 1.08	0.72	0.62, 0.84
Ethnicity/Race				
White, Non-Hispanic	ref		ref	
Hispanic	1.01	0.87, 1.18	0.95	0.80, 1.13
Black, Non-Hispanic	0.99	0.84, 1.16	0.91	0.77, 1.09
Asian, Non-Hispanic	0.94	0.77, 1.15	0.90	0.73, 1.10
Other or Multi-Racial, Non-Hispanic	0.87	0.66, 1.16	0.89	0.66, 1.20

Table 6, continued. Variables associated with knowledge of the universal recommendation, adjusted and unadjusted estimates, by demographic characteristics and knowledge, attitude, and belief variables, National Flu Survey, March 2012

	Unadjusted Prevalence Ratio for Knowledge of Recommendation[a]		Adjusted Prevalence Ratio for Knowledge of Recommendation[b]	
	PR	95%CI	PR	95%CI
Provider visit since July 1, 2011				
Yes	1.10	0.99, 1.22	0.99	0.88, 1.12
No	ref		ref	
High risk health condition[d]				
Yes	1.18	1.08, 1.30	1.03	0.92, 1.16
No	ref		ref	
Recommended before universal recommendation[e]				
Yes	1.16	1.05, 1.29	1.11	0.94, 1.30
No	ref		ref	
Perceives self in group currently recommended for vaccine				
Yes	1.63	1.48, 1.79	1.52	1.36, 1.71
No	ref		ref	
How effective do you think the flu vaccine is in preventing the flu?				
Somewhat or very effective	1.3	1.11, 1.53	1.07	0.89, 1.28
Not too or not at all effective	ref		ref	
If you do not get a flu shot what are your chances of getting the flu?				
Very or somewhat high	1.5	1.36, 1.64	1.28	1.16, 1.43
Very or somewhat low	ref		ref	
How safe do you think the flu vaccine is?				
Very or somewhat safe	1.34	1.12, 1.61	1.05	0.86, 1.29
Very or somewhat unsafe	ref		ref	
How affected would your daily activities be if you got the flu?				
Very or somewhat disrupted	1.33	1.14, 1.56	1.18	1.00, 1.40
Not very or not at all disrupted	ref		ref	

[a] Unadjusted model with knowledge of the universal recommendation as the outcome
[b] In a logistic regression model of knowledge of universal recommendation, controlling for age, sex, education, race/ethnicity, doctor visit, previous recommendation, high risk condition, awareness of being recommended, severity, susceptibility, efficacy, and safety
[c] Age categories based on ACIP recommendations for influenza vaccination
[d] These health conditions place an individual at increased risk of complications from influenza and include asthma, diabetes, heart disease, liver conditions, weakened immune systems, lung conditions other than asthma, kidney conditions, obesity, sickle cell anemia or other anemia, and neurological or neuromuscular conditions,
[e] Combines variables measuring respondent high-risk health condition, household contact with persons with high-risk health conditions, close contact with an infant under 6 months, and health care workers with direct patient contact, as well as individuals over 50 years of age.

Appendix A. IRB Exemption

RE: Exemption Question
Wack, Kevin Joseph
Sent: Tuesday, November 20, 2012 12:05 PM
To: Berns, Abby Lynn; IRB-L@LISTSERV.CC.EMORY.EDU

Abby,

Thank you for your question regarding the need for IRB oversight. The IRB is only responsible for oversight if the project involves human subjects research. According to the federal regulations, a human subject is "a living individual about whom an investigator obtains (1) data through *intervention* or *interaction*, or (2) Identifiable private information." Since your project is secondary data analysis (no interaction or intervention), and the dataset is completely devoid of identifiable private information, you are not required to have IRB oversight.

If you have any questions, or if you think there are other factors that may necessitate IRB oversight, please let me know. Thanks!

Kevin Wack, BA
Analyst Assistant
Education and Quality Assurance
Emory University Institutional Review Board
1599 Clifton Rd, Atlanta, GA 30322
Phone: (404)712-8548