DEPRESSION, CHRONIC ILLNESS, AND GERIATRIC INFLUENZA AND PNEUMOCOCCAL VACCINE COMPLIANCE

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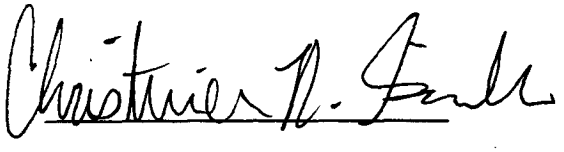

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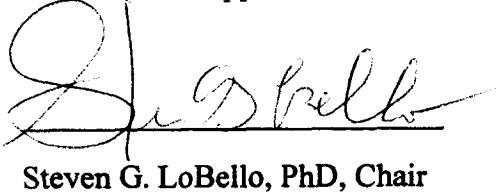

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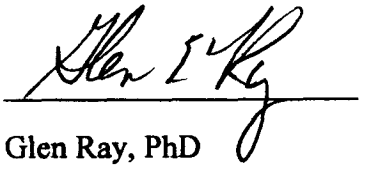

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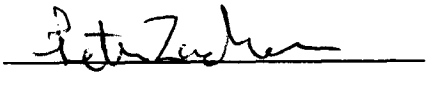

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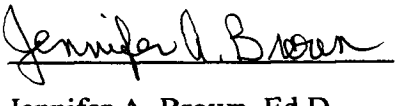

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Depression, Chronic Illness, and Geriatric Influenza and Pneumococcal Vaccine Compliance

by

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Abstract

This study tested a series of hypotheses to determine if the factors involved in geriatric influenza and pneumococcal vaccine compliance are consistent with the core predictions derived from the health belief model (HBM, Rosenstock, 1966; Rosenstock, Strecher& Becker, 1988; van der Pligt 1996). It was predicted that older age, the presence of a chronic illness, and health care access are variables that increase the likelihood of vaccination, while depression was predicted to serve as a barrier to vaccine compliance. Data from the 2006 Behavioral Risk Factor Surveillance Survey (BRFSS), including the Patient Health Questionnaire (PHQ-8, Kroenke, Strine, Spitzer, Williams, Berry, &Mokdad 2009) was used to investigate these hypotheses. The entire sample included 58,021 adults aged ≥ 50 years. Two separate logistic regression models found that age, chronic illness, and health care access were positively related to vaccination in both models while controlling for sex, race, and education level. Depression was not a barrier to vaccination in either models, but was positively related to pneumococcal vaccination.

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List of Abbreviations

APA	American Psychiatric Association
BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease Control
DSM-IV-TR	Diagnostic and statistical manual of mental disorders (4th ed., text revision)
HBM	Health Belief Model
PHQ-8	Patient Health Questionnaire-8 Depression Scale
PHQ-9	Patient Health Questionnaire-9 Depression Scale
SAS	Statistical Analysis Software

Review of Literature

Introduction

Influenza and Pneumonia are both vaccine preventable diseases that are responsible for numerous deaths and hospitalizations in the elderly. These diseases are more deadly than all other vaccine-preventable diseases combined, with a majority of these deaths occurring in people aged 65 and older and with high-risk medical conditions (Fedson, 1994). Furthermore, direct medical expenses for influenza epidemics alone cost the U.S. an estimated $10.4 billion dollars each year (Molinari, et al., 2007). The Centers for Disease Control and Prevention (CDC) recommend that adults aged 65 and older have at least one pneumococcal vaccination, and adults aged 50 and older have annual influenza vaccinations. As the number of people in this age group continues to grow, noncompliance to immunization recommendations is a growing concern for health care professionals. The Centers for Disease Control and Prevention (CDC) have made numerous attempts to raise awareness of the severity of flu and pneumonia-related illnesses, especially for high-risk populations like the elderly. One of the *Healthy People 2010* objectives aimed to have 90% coverage of non-institutionalized elderly adults with influenza and pneumococcal vaccines (U.S. Dept of Health and Human Services, 2000). Coverage rates are high for this age group, especially for those in long-term health care facilities, but there are still many elderly adults living in the community who do not get vaccinated (CDC, 2004). In 2005, both influenza and pneumococcal vaccine coverage

rates (63.3% and 63.7%) for elderly adults remained below the *Healthy People 2010* objective (90%) (CDC, 2006).

The CDC also recommends that all individuals with certain chronic illnesses receive annual influenza and at least one pneumococcal vaccine, as they are also more likely to suffer from complications if infected. A complete list of the chronic illnesses included in the CDC recommendations can be viewed at http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6004a10.htm, but among these are asthma, diabetes, and cardiovascular disease (CDC, 2011). Elderly individuals with chronic illnesses are considered to be at an even higher risk of experiencing complications of flu and pneumonia infections than elderly individuals without any chronic illnesses. Despite the serious consequences of becoming infected, many high-risk elderly adults do not get flu and pneumonia vaccines. A widely-used theory known as the *Health Belief Model* provides a potential explanation as to why this occurs.

The Health Belief Model

The Health Belief Model (Rosenstick, 1966; Rosenstock, Strecher& Becker, 1988; van der Pligt 1996) provides a conceptual framework to aid in predicting and explaining preventative health behaviors, such as vaccine compliance. This theory proposes that the decision to seek out preventative health services is determined by the following factors: *Perceived Susceptibility,* or risk of contractingthe disease, *Perceived*

Severity if that disease is contracted, and *Perceived Benefits and Barriers* of preventing the disease. Rosenstock (1966) labeled these factors as "the variables which constitute readiness to act"(p. 8), and he concluded that another factor, c*ues to action*, stimulated this "readiness to act." Finally, a revision to the HBM added the factor of *self-efficacy,* or confidence in one's ability to take action to prevent the condition (1988). Several studies have provided support for the concepts used in the Health Belief Model. Hochbaum (1958) studied the factors associated with the decision to seek diagnostic x-rays to screen for tuberculosis, a serious infectious illness. Hochbaum found that a belief that one could contract tuberculosis, as well as a belief that early detection of tuberculosis is beneficial, was related to seeking the screening x-ray. Another early study found that perceived susceptibility, severity, benefits, and barriers were significantly related to the decision to seek out preventative dental care (Kegeles, 1963). More recent research has provided support for the Health Belief Model in a wide range of heath behaviors, including preventative health behaviors, medical adherence, and clinic use (Connor & Norman, 1996).

Because of the high rate of mortality and morbidity from flu and pneumonia, the role of health beliefs in vaccine compliance have continuously been an area of focus for health care professionals and public health educators. This has generated research that produced an extensive amount of literature that supports the HBM. For example, results from the 1996 Medicare Current Beneficiary Survey are consistent with the HBM

principles of *perceived susceptibility* and *perceived severity*. The study identified the health beliefs associated with influenza and pneumococcal vaccinations. Specifically, the most common reasons reported by elderly adults for not receiving vaccinations were lack of knowledge, misconceptions about vaccines and vaccine associated illnesses, and lack of recommendations from physicians (CDC, 1999). According to the HBM, individuals are less likely to seek out vaccines if they are unaware of their need for them.

Another study involving 505 healthy elderly people in the Netherlands reported non-compliance (16%) was highest (adjusted Odds Ratio 216, 95% Confidence Interval= 16.2-2883) in people who believed that the flu vaccine produced serious side effects (van Essan, Kuyvenhoven, and Melker, 1997). This illustrates the effect of perceived barriers to health behaviors; people who perceived the flu vaccine as having serious side-effects were less likely to be vaccinated. Another factor associated with non-compliance was the belief that one's health was good (adj. OR 57.9, 95% Confidence Interval= 4.4-770), which suggests that these individuals did not perceive the illness as threatening. The most frequently reported reason for not-complying with vaccine recommendations was the belief of not being susceptible to influenza (van Essan, Kuyvenhoven, and Melker, 1997). Numerous other studies of health beliefs and vaccination status have also produced results that are consistent with the HBM (CDC, 1988; Kohlhammer, Schnoor, Schwartz, Raspe, & Schafer, 2007; Santibanez, et al., 2002).

Chronic Illness

Elderly adults with chronic medical conditions, such as heart disease, asthma, and diabetes have a greater risk of suffering complications from influenza and pneumonia-related illnesses (Barker, 1986). Few studies of vaccine compliance have compared the vaccine compliance rates of healthy elderly adults to elderly adults with chronic illnesses. However, influenza and pneumococcal vaccinations are beneficial for both groups (Nichol, Wuorenma, & von Sternberg, 1998). Surveillance studies have reported that chronic illness is significantly related to geriatric flu and pneumonia vaccination (CDC 2002), but these studies lack an elaborate discussion of this relationship. The relationship between chronic illness and vaccination Specifically, vaccination rates are significantly higher for elderly adults with diabetes or asthma compared to those without diabetes or asthma (CDC 2002). Previous studies have also shown that vaccine compliance is higher for younger adults and children with chronic illnesses than those without chronic illnesses (CDC, 2010; LoBello, in press).

One possible explanation for the lack of focused research in this area is that researchers find it unnecessary to assign risk categories to this age group, as they are already considered a "high-risk" group with regard to flu and pneumonia complications. Nonetheless, the HBM may explain the relationship between chronic illness and geriatric vaccine compliance. For example, elderly adults with chronic illnesses may perceive flu and pneumonia as a greater threat than do elderly adults without chronic illnesses.

According to the HBM, if elderly adults with chronic conditions do perceive flu and pneumonia as more of a threat than do elderly adults without chronic illnesses, they should be more likely to take actions that will help prevent contracting flu and pneumonia. Conversely, vaccine compliance rates should be lower for the elderly adults without chronic illnesses.

Health Care Access

Having adequate health care access (e.g., having a primary physician, health insurance, medical costs, and a higher income) may serve as facilitators of vaccination, which coincides with the HBM principle of perceived benefits of getting vaccinated. For example, Zimmerman et.al. (2003) found that doctor recommendations and knowledge that Medicare covers cost of vaccination were significantly related to elderly influenza vaccination. Another surveillance of elderly vaccination rates found that having a regular source of health care was highly related to flu and pneumonia vaccination (CDC, 2003a).

Depression

Another way to use the HBM to investigate geriatric vaccine compliance is to consider the potential barriers to getting vaccinated. Geriatric depression, a common condition in the elderly, could be a potential barrier to receiving flu and pneumonia vaccines.

This idea is based on an extensive amount of research indicating that depression is associated with noncompliance with medical recommendations (DiMatteo, Lepper, & Croghan, 2000; Cassano & Fava, 2002). Assuming that depression is a barrier to vaccine compliance, flu and pneumonia vaccination rates should be lower among depressed individuals than among individuals who are not depressed.

Other Factors

Finally, previous studies of vaccine compliance have shown that rates of vaccination are highly influenced by sex, race, and education level. In a surveillance of influenza and pneumococcal vaccination rates from 1989 to 2001, rates were much lower for non-Hispanic blacks and Hispanics compared to non-Hispanic whites (CDC, 2003b). Sex and education level are also factors that significantly affect flu and pneumonia vaccination (CDC, 2003a). Therefore, the effects sex, race, and education level on vaccination should be considered in this investigation.

Statement of the Problem

The purpose of this study is to examine data obtained from a population-based survey to determine if the factors involved in influenza and pneumococcal vaccine compliance of adults aged ≥ 50 are consistent with the core predictions derived from the health belief model.

This will be achieved by using two models to test a series of hypotheses that coincide with the Health Belief Model. Influenza vaccination will serve as the outcome variable in model 1, and pneumococcal vaccination will serve as the outcome variable for model 2. The multiple variables used in each model have been compiled into the following hypotheses:

1. According to the Health Belief Model, perceived risk of contracting influenza and pneumonia should increase as age increases. Therefore it is predicted that vaccine compliance is positively and significantly associated with age.
2. Perceived risk should also increase among adults with at least one chronic illnesses. It is predicted that vaccine compliance is higher among elderly adults with cardiovascular disease, diabetes or asthma than among elderly adults without cardiovascular disease, diabetes, or asthma.
3. Having a primary physician, insurance, and a higher income will be viewed as facilitators of vaccination, as they should lead to greater accessibility to health

care and greater rates of vaccination. Therefore, it is predicted that vaccine compliance is positively associated with having insurance and a primary physician. It is also predicted that vaccine compliance will increase as income increases.

4. It is predicted that depression will serve as a barrier to vaccine compliance, and will decrease the likelihood of vaccination.

The remaining variables, sex, race, and education level, are potential confounding variables that have influenced previous studies of vaccine compliance. These variables were statistically controlled in this study.

Method

Participants

The Behavioral Risk Factor Surveillance System (BRFSS) is an annually conducted, nationwide telephone health survey of non-institutionalized adults (CDC, 2007). Each year, participants are randomly selected from the 50 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Guam to answer health-related questions. The aim of the BRFSS is to produce a sample that is representative of the U.S. population. Weighted estimates were reported to account for biasing factors such as the number of adults in a household, non-response, and the probability of a telephone number being randomly selected. The BRFSS data set is available to the public and may be obtained at the CDC web site (CDC, 2006b). In 2006, the BRFSS data were collected from over 350,000 respondents (CDC, 2007).

The participants for this study were non-institutionalized elderly men and women aged 50 years and older. The 2006 BRFSS survey included additional questions based on the Patient Health Questionnaire depression scale (PHQ-8, Kroenke, Strine, Spitzer, Williams, Berry, & Mokdad, 2009). This depression scale was administered with the BRFSS survey in 33 states, two U.S. territories, and the District of Columbia. In 2006, 124,672 men and women aged $\geq$ 50 years were administered the survey and depression scale questions (CDC, 2006b). The average age of the sample was 74.5 years (SD=6.94

years), and there were 42% men and 58% women (weighted percents). Table 1 outlines the age categories and other demographic information (sex, race, education level, and income level), along with the frequency and weighted percentages for the remaining variables used in this study (influenza and pneumococcal vaccine status, chronic illnesses, depression, health insurance, having a regular doctor, medical cost of seeing a doctor).

Measures

Influenza and Pneumococcal Vaccination

Health Belief Model and past research guided variable selection for this study. Influenza and pneumonia vaccination served as the outcome variables in the present study. Vaccination of adults aged 50 years and older was determined based on responses to the following 2006 BRFSS survey questions: "During the past 12 months, have you had a flu shot?" and "Have you ever had a pneumonia shot?" The predictor variables include self-reported prior diagnosis of a chronic illness (diabetes, cardiovascular disease, or asthma), and diagnosis of depression. Demographic variables (sex, age, race, and education level) and health care access variables (having a primary physician, health insurance, medical costs of seeing a doctor, and annual income level) were included in both models of this study.

Chronic Illnesses

All variables were responses to BRFSS survey questions. The first predictor variables involved respondents who reported being previously diagnosed with a chronic illness. The present study focused specifically on diabetes, cardiovascular disease, and asthma. Participants were considered to have cardiovascular disease if they responded yes to either of the following questions: "Has a doctor, nurse, or other health professional ever told you that you hada heart attack, also called a myocardial infarction?" and "Has a doctor, nurse, or other health professional ever told you that you had a stroke?" Participants were considered to have asthma if they answered yes to the question, "Have you ever been told by a doctor, nurse, or other health professional that you had asthma?" Participants were considered to have diabetes if they answered yes to the question, "Have you ever been told by a doctor that you have diabetes?"

Depression

Depression was hypothesized to be a barrier to influenza and pneumococcal vaccination. This prediction was based on previous research showing that depression is associated with noncompliance to medical recommendations (DiMatteo, Lepper, & Croghan, 2000; Cassano & Fava, 2002). Depression was determined by totaling each participant's responses to the PHQ-8 questions included in the 2006 BRFSS survey. The PHQ-8 questions were adapted for use in the depression and anxiety survey scale administered as part of the 2006 BRFSS to assess participants' depression symptoms over

the 14 days prior to their survey administration. The PHQ-8 is a revision of the PHQ-9, a depression scale designed to coincide with the nine requirements that warrant a diagnosis of depression in the *Diagnostic and Statistical Manual of Mental Disorders*, 4th Edition, Text-Revision (DSM-IV-TR) (American Psychiatric Association [APA], 2000). The only revision made to the PHQ-9 was the removal of the ninth item, which questions participants about experiencing frequent thoughts of death or suicide. This item was removed from the Patient Health Questionnaire in situations where researchers could not take necessary actions for participants who are at risk for suicide.

The PHQ-8 scoring method used in the present study is based on previous research by Fan, et al. (2009) and LoBello & Zachar (2009). Depression was calculated based on the number of days during which each individual symptom occurred, and then classified into four categories using a 0-3 scale (0-1 day = 0 "not at all," 2-6 days = 1 "several days," 7-11 days = 2 "more than half the days," and 12-14 days = 3 "nearly every day"). The category score for each of the 8 symptoms was then summed together to arrive at a total score for the PHQ-8. The participant's total PHQ-8 score was assigned to one of three categories: no depression (4 or less), minor depression (5-9), or major depression (10 or greater).

Health Care Access

The remaining variables included in the present study were potential barriers to or benefits of getting vaccinated. They were chosen based on their relationship to vaccine

compliance in previous studies (CDC, 2003; Ward & Draper, 2008). The health care access variables were based on answers to the following questions from the 2006 BRFSS questionnaire: "Was there a time in the past 12 months when you needed to see a doctor but could not because of cost?", "Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMO's, or government plans such as Medicare?", and "Do you have one person you think of as your personal doctor or health care provider?" Income level (6 categories) was also included as a health care access variable.

Covariates

Potential confounding variables included sex, age (5 categories), race (4 categories), and education level (4 categories). Table 1 summarizes the frequencies and weighted percents for all of the variables used in this study, and for all eligible study participants ≥ age 50 in the 2006 BRFSS sample.

Statistical Analysis and Models

The data were analyzed using the SAS *Surveylogistic module*, a statistical analysis procedure created for use with complex survey designs. Logistic regression was used to determine if relationships exist between vaccine compliance and each of the variables in the models. Influenza and pneumococcal vaccine status (receiving or not receiving) served as the outcome variables in each model. The remaining variables included: prior diagnosis of a chronic illness (asthma, diabetes,or cardiovascular disease), having

adequate health care access (primary physician, health insurance, medical costs,and annual income level), prior diagnosis of minor or major depression, and measurement of covariates. All variables used in this study were based solely self-reported answers of each respondent.

Table 1.
Demographics and Weighted Percentages of 2006 BRFSS Respondents, Adults Ages ≥ 50 Years

Variable	N (Percent)	Weighted Percent
Sex		
Men	46,303 (37%)	46%
Women	78,369 (63%)	54%
Age		
> 85	5,367 (4%)	4%
80-84	8,664 (7%)	6%
75-79	11,979 (10%)	10%
70-74	14,451 (12%)	10%
65-69	17,100 (14%)	12%
60-64	19,988 (16%)	16%
55-59	23,456 (19%)	19%
50-54	23,667 (19%)	24%
Race		
Other	7,786 (6%)	6%
Hispanic	6,929 (6%)	11%
Black	8,298 (7%)	8%
White	101,659 (82%)	75%
Education level		
Did not graduate high school	15,041 (12%)	13%
High school graduate	39,407 (32%	29%
Attended college or technical school	32,425 (26%)	26%
Graduated college or technical school	37,452 (30%)	31%
Unknown	347 (.5%)	1%
Income Level		
Less than $15, 000	15,179 (12%)	11%
$15,000 - $25,000	20,615 (17%)	15%
$25,000 - $35,000	15,046 (12%)	11%
$35,000 – $50,000	17,357 (14%)	13%
More than $50,000	36,725 (29%)	35%
Unknown	19,750 (16%)	15%

Table 1.
Demographics and Weighted Percentages of 2006 BRFSS Respondents, Adults Ages ≥ 50 Years (cont'd).

Variable	N (Percent)	Weighted Percent
See Doctor on a Regular Basis		
Yes	112,587 (91%)	90%
No	11,791 (9%)	10%
Have Insurance		
Yes	114,998 (92%)	92%
No	9,472 (8%)	8%
Could Not See Doctor Because of Cost		
Yes	10,615 (9%)	9%
No	114,057 (91%)	91%
Had Flu Shot in Past 12 Months		
Yes	64,178 (52%)	49%
No	59,340 (48%)	51%
Had Pneumonia Shot Ever		
Yes	52,819 (43%)	39%
No	70579 (57%)	61%
Ever diagnosed with depression		
Minor depression	2,644 (2%)	2%
Major depression	5,582 (5%)	5%
No depression	116,446 (93%)	93%
Ever diagnosed with heart attack		
Yes	11354 (9%)	9%
No	113318 (91%)	91%
Ever diagnosed with a stroke		
Yes	7,188 (6%)	6%
No	117,483 (94%)	94%
Ever told had asthma		
Yes	15,674 (13%)	12%
No	108,998 (94%)	88%
Ever told by doctor you have diabetes		
Yes	18,754 (15%)	16%
No	103,809 (87%)	82%
Borderline or pre-diabetes	2,109 (2%)	2%

Results

The primary purpose of this study was to determine if the factors related to influenza and pneumococcal vaccine compliance of adults age ≥ 50 are consistent with the core predictions derived from the health belief model. Two separate models were used for each outcome variable, and a series of hypotheses were tested using logistic regression.

Model 1: Influenza Vaccination

There were 123,046 respondents from the 2006 BRFSS who met the inclusion criterion for age (≥50), and who answered the survey questions about influenza vaccination and all other variables used in model one. One thousand six hundred twenty-six respondents were excluded from the study due to missing values (responses) for the questions about influenza vaccination or any of the additional variables used in model 1. The entire sample for model 1 consisted of 63,977 adults who reported having a flu shot in the past 12 months and 59,069 adults who reported not having a flu shot in the past 12 months. Table 2 summarizes the results of the bivariate analysis of variables association of model variables with flu shot status. The odds ratio estimates for influenza vaccination are listed in table 3.

Hypothesis 1 predicted that age was positively and significantly related to vaccination. Results of model 1 indicated that the likelihood of receiving influenza vaccination did increase as age increased, thus this hypothesis was supported.

Hypothesis 2 predicted that vaccine compliance was higher among elderly adults with cardiovascular disease, diabetes, or asthma than among elderly adults without cardiovascular disease (prior diagnosis of heart attack or stroke), diabetes, or asthma. Results of model 1 indicated that adults who reported having a chronic illness of diabetes, or asthma were more likely to receive influenza vaccines. Respondents who reported having a prior diagnosis of a heart attack were more likely to report influenza vaccination. However, a prior diagnosis of stroke was not significantly related to influenza vaccination. Because this study considered respondents to have cardiovascular disease if they reported having a prior diagnosis of either heart attack or stroke, cardiovascular disease is positively related to influenza vaccination. Hypothesis 2 was supported in model 1.

Hypothesis 3 predicted that the health care access variables (having a primary physician, health insurance and a higher annual income) would be positively related to influenza vaccination. Effects of medical costs are also examined in this hypothesis. Results of model 1 indicated that health care access was also significantly related to influenza vaccination. Adults who reported having a primary physician were 2.1 (95% CI=1.9-2.4) times more likely to be vaccinated than those who did not see a doctor on a regular basis. Additionally, adults that have insurance were 1.7 (95% CI= 1.5-2.0) times more likely to be vaccinated than adults who did not have health insurance. Having a lower annual income (less than $15,000) significantly decreased the likelihood of

receiving influenza vaccinations. Respondents who could not see a doctor because of cost were also much less likely than the comparison group to report influenza vaccination (OR=.86, 95% CI=.77-.97). Hypothesis 3 was supported in model 1.

Hypothesis 4 predicted that depression would be associated with a decreased likelihood of influenza vaccination. However, results indicated that depression was not significantly related to influenza vaccination. Therefore, hypothesis 4 was not supported in model one.

Results of the measurement of covariates (sex, race, and education level) revealed that women were more likely to report vaccination than men. With regard to race, African-Americans (35%) and Hispanics (34%) were much less likely to be vaccinated than Caucasians (52%). Education levels of high school graduate or greater were positively related to influenza vaccination. Respondents who were not high school graduates were less likely to report vaccination than college graduates (OR=.66, 95% CI=.59-.73).

Table 2.
Bivariate Analysis of Variables Associated with BRFSS Respondents Aged ≥ 50 Years Receiving Flu Shot (n=124,672).

Model Variable	Flu Shot (n=63,926)	No Flu Shot (n=59,001)	Type III Effects/Wald x^2 (df) p[a]
Age			
50- 54 years	7,537 (29%)	15,934 (71%)	
55-59 years	9,038 (37%)	14,196 (63%)	
60-64 years	9,235 (45%)	10,589 (55%)	
65-69 years	9,885 (58%)	7,051 (42%)	
70-74 years	9,646 (67%)	4,680 (33%)	478.4 (7) p= <.0001
75-79 years	8,571 (71%)	3,297 (29%)	
80-84 years	6,380 (74%)	2,191 (26%)	
85+ years	3,886 (74%)	1,402 (26%)	
Sex			
Men	22,841 (47%)	22,973 (53%)	8.4 (1) p= .0038
Women	41,337 (51%)	36,367 (49%)	
Race			
White	54,716 (52%)	46,141 (48%)	
Black	2,994 (35%)	5,171 (66%)	103.2 (3) p= >.0001
Hispanic	2,486 (34%)	4,350 (66%)	
Other/Unknown	3,982 (49%)	3,678 (51%)	
Education Level			
Did not graduate high school	7,354 (44%)	7,492 (56%)	
High school graduate	20,247 (50%)	18,766 (50%)	
Attended college or technical school	16,367 (47%)	15,837 (53%)	70.5 (4) <.0001
Graduated college or technical school	20,083 (52%)	17,128 (48%)	
Other/unknown	127 (36%)	117 (64%)	

Table 2.
Bivariate Analysis of Variables Associated with BRFSS Respondents Aged ≥ 50 Years Receiving Flu Shot (n=124,672) (cont'd).

Model Variable	Flu Shot (n=63,926)	No Flu Shot (n=59,001)	TypeIII Effects/Wald X^2 (df) p[a]
Income Level			
Less than 15,000	7,345 (44%)	7,702 (56%)	
15,000-25,000	11,052 (51%)	9,410 (49%)	
25,000-35,000	7,999 (52%)	6,958 (48%)	
35,000-50,000	8,900 (50%)	8,365 (50%)	34.6 (5) p= <.0001
More than 50,000	17,996 (46%)	18,554 (54%)	
Other/unknown	10,886 (55%)	8,351 (45%)	
Ever had pneumonia shot			
Yes	41,245 (76%)	11,573 (24%)	2505.8 (1)
No	22,882 (31%)	47,697 (69%)	p= <.0001
Ever diagnosed with heart attack			
Yes	7,234 (62%)	4,026 (38%)	8.0 (1)
No	56,944 (48%)	55,314 (52%)	p= 0.0046
Ever diagnosed with stroke			
Yes	4,443 (59%)	2,676 (41%)	0.2 (1)
No	59,735 (48%)	56,664 (52%)	p=0.6300
Ever diagnosed with asthma			
Yes	9,267 (57%)	6,294 (43%)	9.6 (1)
No	54,911 (48%)	53,046 (52%)	p= 0.0020
Ever diagnosed with diabetes			
Yes	11,884 (60%)	6,704 (40%)	
No	51,015 (47%)	51,735 (53%)	54.2 (2) p=<.0001
Borderline diabetes	1,189 (50%)	901 (50%)	
See a doctor on a regular basis			
Yes	60,936 (52%)	50,659 (48%)	118.2 (1)
No	3,120 (24%)	8,519 (76%)	p=<.0001
Have Insurance			
Yes	61,689 (51%)	52,293 (49%)	54.5 (1)
No	2,406 (22%)	6,936 (78%)	p=<.0001
Could not see a doctor because of cost			
Yes	3,727 (33%)	6,765 (67%)	8.5 (1)
No	60,451 (51%)	52,575 (49%)	p= 0.0036
Ever diagnosed with depression			
Minor depression	1,333 (46%)	1,311 (54%)	
Major depression	2,568 (44%)	3,012 (56%)	2.0 (2) p= 0.3722
No depression	60,277 (49%)	5,017 (51%)	

Table 3.
Odds Ratio Estimates for Model 1: Influenza Vaccination

Model Variables	Adjusted Odds Ratio	95% Confidence Interval
Age		
50-54 years	--	--
55-59 years	1.3	1.2 – 1.4
60-64 years	1.9	1.7 – 2.1
65-69 years	3	2.8 – 3.3
70-74 years	4.4	4 - 4.9
75-79 years	5.3	4.7 – 6
80-84 years	6.5	5.7 – 7.3
85+ years	6.6	5.6 – 7.7
Chronic Illness		
Diabetes		
No	--	--
Borderline	1.0	.84-1.3
Yes	1.4	1.3-1.5
Cardiovascular Disease		
No	--	--
Yes	1.3	1.1-1.4
Stroke		
No	--	--
Yes	1.1	0.9-1.2
Asthma		
No	--	--
Yes	1.5	1.4-1.6
Health Care Access		
See a doctor on a regular basis		
No	--	--
Yes	2.1	1.9-2.4
Have Insurance		
No	--	--
Yes	1.7	1.5-2.0
Could not see a doctor because of cost		
No	--	--
Yes	.86	.77-.97
Annual Income		
> 50,000	--	--
35,000-50,000	1.0	0.9-1.1
25,000-35,000	.98	.89-1.1
15,000-25,000	.96	.87-1.1
< 15,000	.71	.68-.87
unknown	.97	.89-1.1

Table 3.
Odds Ratio Estimates for Model 1: Influenza Vaccination (cont'd).

Model Variables	Adjusted Odds Ratio	95% Confidence Interval
Depression variables		
No Depression	--	--
Minor Depression	.86	.68-1.0
Major Depression	1.0	.82-1.1
Demographic Variables		
Sex		
Female	--	--
Male	.90	.85-.95
Race		
White	--	--
Black	.52	.47-.58
Hispanic	.60	.53-.69
Other/unknown	.90	.78-1.0
Education Level		
Graduated college	--	--
Attended college or technical school	.80	.74-.86
High school graduate	.80	.75-.86
Did not graduate high school	.66	.59-.73
Unknown/other	0.3	.17-.54

Model 2: Pneumococcal Vaccination

There were 122,928 respondents from the 2006 BRFSS who met the inclusion criterion for age (≥50), and who answered the survey questions about pneumococcal vaccination and all other variables used in model one. 1,744 respondents were excluded from the study due to missing values (responses) for the questions about pneumococcal vaccination or any of predictor variables or covariates in model 2. The sample consisted of 52,650 respondents who reported ever having a pneumonia vaccine, and 70,278 respondents who reported never having a pneumonia shot. Table 4 summarizes the results of the bivariate analysis of variables association of model variables with pneumonia shot status. The odds ratio estimates for pneumococcal vaccination are listed in table 5.

Hypothesis 1 predicted that age is positively and significantly related to vaccination. Results indicated that the likelihood of receiving pneumonia vaccines increased with age. Hypothesis 1 was supported in model 2.

Hypothesis 2 predicted that vaccine compliance is higher among elderly adults with cardiovascular disease (prior diagnosis of heart attack or stroke), diabetes, or asthma than among elderly adults without cardiovascular disease, diabetes, or asthma. The adults who reported having diabetes or asthma were also more likely to be vaccinated. Cardiovascular disease, including heart attack and stroke, were significantly and positively related to pneumococcal vaccination. Of all the chronic illnesses, a prior diagnosis of asthma was the strongest predictor of pneumococcal vaccination.

Respondents with asthma were 2.5 times more likely to report pneumococcal vaccination than respondents without asthma (95% CI= 2.3-2.7) Hypothesis 2 was supported in model 2.

Hypothesis 3 predicted that the health care access variables (having a primary physician, health insurance and a higher annual income) would be positively related to influenza vaccination. The effects of medical costs are also examined in this hypothesis. With the health care access variables, having a primary physician (OR=1.8, 95% CI= 1.6-2) and health insurance (OR=1.3, 95% CI=1.1-1.5) increased the likelihood of reporting pneumonia vaccination. However, medical cost was not associated with pneumonia vaccination. Excluding the "other/unknown" category, income level was positively and significantly related to pneumonia vaccination. Hypothesis 3 was supported in model 2, with the exception of medical costs.

Hypothesis 4 predicted that depression would be associated with a decreased likelihood of vaccination. However, elderly adults who met the criteria for major depression (PHQ-8 score of $\geq$ 10) or minor depression (PHQ-8 score of 5-9) were significantly more likely to be vaccinated compared to elderly adults with no depression (PHQ-8 score of $\leq$ 4). Because depression was not a barrier to pneumonia vaccination (i.e., it did not decrease the likelihood of vaccination), hypothesis 4 was not supported in model 2.

Consistent with model 1, women were more likely than men to be vaccinated and African-American and Hispanic respondents were less likely to be vaccinated than the Caucasian comparison group. Results also indicated that respondents with no high school diploma were less likely to report being vaccinated than respondents who were college graduates (OR=.69, CI 95%=.61-.77).

Table 4.
Bivariate Analysis of Variables Associated with BRFSS Respondents Aged ≥ 50 Years Receiving Pneumonia Vaccine (n=122,297)

Model Variable	Pneumonia Vaccine (n= 52,649)	No Pneumonia Vaccine (n= 70,278)	Type III Effects/Wald X^2 (df) p[a]
Age			
50-54 years	3,820 (15%)	19,632 (85%)	
55-59 years	5,200 (21%)	18,017 (79%)	
60-64 years	6,317 (30%)	13491 (70%)	
65-69 years	8,845 (51%)	8,073 (49%)	2665.8 (7)
70-74 years	9,640 (66%)	4,673 (34%)	p= <.0001
75-79 years	8,802 (72%)	3,054 (28%)	
80-84 years	6,411 (75%)	2,148 (25%)	
85+ years	3,784 (68%)	1,491 (33%)	
Sex			
Men	18,353 (37%)	27,405 (63%)	2.4 (1)
Women	34,466 (41%)	43,174 (59%)	p= 0.1238
Race			
White	44,983 (42%)	55,793 (58%)	
Black	2,574 (33%)	5,574 (67%)	114.6 (3)
Hispanic	1,973 (22%)	4,854 (78%)	p= <.0001
Other/Unknown	3,289 (40%)	4,358 (60%)	
Education Level			
Did not graduate High School	7,029 (39%)	7,794 (61%)	
High School graduate	17,852 (43%)	21,116 (57%)	
Attended college or technical School	13,737 (39%)	18,438 (61%)	50.4 (4) p= <.0001
Graduated college or technical school	14,085 (35%)	23,105 (65%)	
Other/Unknown	116 (54%)	126 (46%)	
Income Level			
Less than 15,000	7,449 (44%)	7,587 (56%)	
15,000-25,000	10,522 (48%)	9,917 (52%)	
25,000-35,000	7,131 (45%)	7,818 (55%)	65.8 (5)
35,000-50,000	7,150 (40%)	10,105 (60%)	p= <.0001
More than 50,000	11,009 (28%)	25,521 (72%)	
Other/Unknown	9,558 (47%)	9,631 (53%)	

Table 4.
Bivariate Analysis of Variables Associated with of BRFSS Respondents Aged ≥ 50 Years Receiving Pneumonia Vaccine (n=123,398) (cont'd)

Model Variable	Pneumonia Vaccine (n= 52,649)	No Pneumonia Vaccine (n= 70,278)	Type III Effects/Wald X^2 (df) p[a]
Had Flu Shot Past 12 Months			
Yes	41,245 (61%)	22,882 (39%)	25.5.1 (1)
No	11,573 (18%)	47,697 (82%)	p= <.0001
Ever Diagnosed with Heart Attack			
Yes	7,207 (59%)	4,040 (41%)	25.5 (1)
No	45,612 (37%)	66,539 (63%)	p= <.0001
Ever Diagnosed with Stroke			
Yes	4,482 (59%)	2,624 (41%)	15.9 (1)
No	48,337 (38%)	67,955 (62%)	p= <.0001
Ever Diagnosed with Asthma			
Yes	9,056 (55%)	6,492 (45%)	300.3 (1)
No	43,763 (37%)	64,087 (63%)	p= <.0001
Ever Diagnosed with Diabetes			
Yes	11,340 (56%)	7,231 (44%)	222.9 (2)
No	40,382 (36%)	62,357 (64%)	p= <.0001
Borderline	1,097 (43%)	991 (57%)	
See a Doctor on a Regular Basis			
Yes	50,173(41%)	61,315 (59%)	31.8 (1)
No	2,542 (20%)	9,085 (80%)	p= <.0001
Have Insurance			
Yes	50,729 (41%)	63,144 (59%)	0.7 (1)
No	2,021 (19%)	7,311 (81%)	p= 0.0045
Could Not See a Doctor Because of Cost			
Yes	3,460 (31%)	7,025 (69%)	5.9 (1)
No	49,359 (40%)	63,554 (60%)	p= 0.0149
Ever diagnosed with depression			
Major depression	2,526 (43%)	3,054 (57%)	
Minor depression	1,260 (44%)	1,384 (56%)	23.2 (2) p= <.0001
No depression	49,033 (39%)	66,141 (61%)	

Table 5.
Odds Ratio Estimates for Model 2: Pneumococcal Vaccination

Model Variables	Adjusted Odds Ratio	95% Confidence Interval
Age		
50- 54 years	--	--
55-59 years	1.3	1.2-1.5
60-64 years	2.2	2-2.5
65-69 years	5.3	4.8-5.9
70-74 years	10.1	9-11.3
75-79 years	13.5	11.9-15.2
80-84 years	15.6	13.8-17.7
85+ years	11	9.2-13.1
Chronic Illnesses		
Diabetes		
No	--	--
Borderline	1.2	.93-1.4
Yes	1.9	1.8-2.1
Cardiovascular Disease		
No	--	--
Yes	1.4	1.3-1.5
Stroke		
No	--	--
Yes	1.3	1.1-1.5
Asthma		
No	--	--
Yes	2.5	2.3-2.7
Health Care Access		
See a doctor on a regular basis		
No	--	--
Yes	1.8	1.6-2.0
Have Insurance		
No	--	--
Yes	1.3	1.1-1.5
Could not see a doctor because of cost		
No	--	--
Yes	1.1	.99-1.3
Annual Income		
> 50,000	--	--
35,000-50,000	1.3	1.2-1.4
25,000-35,000	1.3	1.2-1.4
15,000-25,000	1.4	1.2-1.5
< 15,000	1.3	1.1-1.5
unknown	1.2	1.1-1.3

Table 5.
Odds Ratio Estimates for Model 2: Pneumococcal Vaccination (cont'd)

Model Variables	Adjusted Odds Ratio	95% Confidence Interval
Depression		
No Depression	--	--
Minor Depression	1.3	1.0-1.6
Major Depression	1.4	1.2-1.7
Demographic Variables		
Sex		
Female	--	--
Male	.93	.87-.98
Race		
White	--	--
Black	.68	0.6-.78
Hispanic	.38	.32-.44
Other/unknown	.86	.74-1.0
Education Level		
Graduated college	--	--
Attended college or technical school	1.0	.97-1.1
High school graduate	.97	.90-1.1
Did not graduate high school	.69	.61-.77
Unknown/other	.98	.38-2.5

Discussion

Implications of Findings

The first hypothesis was supported by this study in both models. Age is significantly and positively related to influenza and pneumococcal vaccination. The findings of hypothesis 1 are consistent with the HBM, suggesting that perceived threat of flu and pneumonia increases with age. Knowing this, efforts to raise the perceived threat of younger elderly adults could increase flu and pneumonia vaccination rates. The CDC have done this by lowering the influenza vaccine recommendation age to 50 and older (CDC 2000). Further efforts should include lowering the age in pneumococcal vaccine recommendations as well.

The second hypothesis was also supported in both models in this study. Respondents with a prior diagnosis of diabetes, asthma, or cardiovascular disease were more likely to report influenza and pneumonia vaccination. However, stroke was not related to influenza vaccination. The relationships that exist between chronic illnesses and vaccination in this study are not surprising, as these groups are known to suffer the worst consequences if infected with influenza or pneumonia (Fedson, 1994).

The results of hypothesis 2 are also consistent with the health belief model concerning the relationship of *perceived susceptibility* and *perceived severity* to preventive health behavior. A likely interpretation is that the adults with chronic illnesses are more likely to be vaccinated because they perceive flu and pneumonia as more

threatening to their health. However, it is also possible that adults with chronic illnesses are exposed to more *cues to action*. For instance, adults with chronic illnesses probably see a physician more regularly, thus increasing exposure to more cues (i.e., physician recommendations, knowledge of vaccines), than adults without chronic illnesses. Future efforts aimed at increasing vaccine uptake should continue to prompt flu and pneumonia vaccination among high-risk adults, but different methods may be needed to educate otherwise healthy adults about the benefits of vaccination.

More research is needed to explore the relationship between stroke and vaccination. The results of this study indicated that history of stroke is associated with greater likelihood of pneumonia vaccination, but not pneumonia vaccination. Of all the chronic medical conditions included in this study, stroke is the most likely to result in significant physical and cognitive impairment. It may be that stroke survivors are better able to recall a recent flu vaccination, as compared to a pneumonia vaccination that is not repeated annually. Problems with accurate recall may be more likely among stroke survivors as compared to respondents with diabetes or history of heart attack. An informative line of research would investigate the link between stroke and recall of routine medical procedures.

The third hypothesis was also supported in both models. However, an exception here was the relationship between medical cost of seeing a doctor and pneumonia vaccination. Cost of seeing a physician was a barrier to influenza vaccination, but not

pneumonia vaccination. The difference is not large, and may be related to differences in insurance reimbursement for the two vaccines. The result is puzzling because flu vaccination is widely available outside of physicians' offices, often at low or no cost.

The relationship between health care access variables and vaccination is consistent with the health belief model principles of *perceived benefits, cues to action,* and *self-efficacy.* For example, adults with primary physicians are likely exposed to more cues that facilitate vaccination, such as doctor recommendations, than adults without primary physicians. Additionally, adults who have health insurance are probably more likely to go the doctor, and also may be more confident in their ability to prevent flu and pneumonia than adults without health insurance. Efforts to increase health care access for elderly adults may improve flu and pneumonia vaccination rates. Future research should focus specifically on the relationship between health care access and vaccination.

The fourth hypothesis was not supported in either models of this study. Depression was not a barrier to vaccination in either models, but increased the likelihood of pneumonia vaccination. Future research should focus on this unexpected relationship between depression and pneumonia vaccination.

The remaining variables were included in this study to control for potential confounding effects. As expected, sex, race, and education level was significantly related to vaccination in both models. Specifically, women were more likely report vaccination than men, and African-American and Hispanic respondents were less likely to report

vaccination than Caucasian respondents in both models. Respondents who were not high school graduates were significantly less likely to report vaccination than college graduates in both models. This suggests that more efforts are needed to increase vaccination rates for groups that consistently produce low vaccination rates. One way to do this is to use the media and other strategies to target the groups less likely to be vaccinated. For example, ads should educate the public that men are consistently less likely to be vaccinated than women. Also, efforts should be made to increase awareness about influenza and pneumonia, vaccines should be made easily accessable in African-American and Hispanic communities.

Limitations

There are several limitations of this study. First, all categories are based on self-reported information of respondents rather than medical records, thus making the study more vulnerable to recall bias or social desireability effects. Additionally, the depression categories are based on questions from the PHQ-8, which is an effective tool for identifying current depressive episodes; however, a clinical interview is needed for an actual depression diagnosis. Self-report data are subject to respondents' under-reporting or over-reporting of healthy behaviors. Also it should be mentioned that health beliefs were not directly measured in this study, and the consistencies between the results of this study and the Health Belief Model are based on inference.

Conclusion

This study attempted to better understand geriatric influenza and pneumococcal vaccine compliance, as this group may suffer the worst consequences if infected with these diseases. The study was designed and the results were interpreted within the framework of the Health Belief Model. Many of the findings of this study were consistent with previous research.

Overall, future research is needed to better understand the relationships between stroke, medical costs, and flu and pneumonia vaccination. Particularly important is the significant finding between depression and pneumonia vaccination. Future studies should focus on replicating this study to understand why depression facilitates pneumonia vaccination but not flu vaccination.

Additionally, this study provides support that health care should be made more accessable to elderly adults in order to increase vaccination rates. One way to do this is to make vaccines more affordable, especially for elderly adults with low income or those who do not have health insurance. Because having a primary physician was related to vaccination, physicians should be encouraged to strongly recommend that all elderly patients receive flu and pneumonia vaccines. Perhaps requiring standing orders for all patients aged 50 and older, as they currently do in long-term health care facilities (American Medical News, 2002), is a potential way to increase vaccine compliance.

This study also indicates that health care professionals should target men, African-Americans, and Hispanics to increase vaccine compliance for these groups.

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