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A Comparison of Influenza & Tdap Vaccination Rates by Characteristics of Child-Bearing-Aged Women

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A Comparison of Influenza & Tdap Vaccination Rates by Characteristics of Child-Bearing-Aged Women

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Abstract

Background

The Advisory Committee on Immunization Practices recommend childbearing-aged women receive an annual influenza vaccine, one dose of Tdap instead of TD after 18 years of age, and one dose of Tdap during the 3rd trimester of each pregnancy. Despite these recommendations, influenza and Tdap vaccination rates remain lower than current goals.

Objectives

The purpose was to assess influenza and Tdap vaccination rates among women of childbearing age by pregnancy status, age group, and race/ethnicity.

Methods

The retrospective secondary data analysis included a nationally representative sample of women aged 18 to 44 years from the 2014 Behavioral Risk Factors Surveillance System, a national health-related telephone survey of non-institutionalized adults ≥18 years old. Descriptive statistics and X^2 analysis were performed to estimate vaccination rates and compare them among the stratified groups with alpha set as 0.01 for this study.

Results

There were 66,894 childbearing-aged women and 3.8% of them were pregnant during data collection. Thirty-seven percent received an influenza vaccination within the past 12 months and 59.0% received a Tdap vaccination within the recommended time frame. Pregnancy status, age group, and race/ethnicity were predictors of influenza vaccination receipt among childbearing-aged women. Similarly, age group and race/ethnicity were predictors of Tdap vaccination receipt among childbearing-aged women. However, pregnancy status was not a predictor of Tdap vaccination receipt among childbearing-aged women.

Conclusions

Both influenza and Tdap vaccination rates among childbearing aged women were lower than the national goals. Further research is needed to identify barriers to vaccinations in this population.

Background

Standard vaccination programs in the United States have traditionally focused on children immunization programs. With recent outbreaks of vaccine preventable diseases, such as influenza and pertussis, recommendations suggested increasing focus on adult vaccination interventions to improve vaccination coverage and maintain herd immunity (Williams, et al., 2016). In particular, the Advisory Committee on Immunization Practices (ACIP) recommended pregnant women and childbearing-aged women (18-44 years) receive an annual influenza vaccine, one dose of Tdap instead of TD after turned 18 years of age, and one dose of Tdap during the 3rd trimester (27-36 weeks gestation) of each pregnancy (Annunziata, Rak, Del Buono, DiBonaventura, Krishnarajah, 2012; Centers for Disease Control and Prevention (CDC), 2013; HealthyPeople 2020, 2016; Kharbanda, Parker, Nordin, Hedblom, & Rolnick, 2013). Recommendations were developed as both influenza and pertussis pose significantly increased risk for complications to pregnant woman, fetuses, and newborns (O'Halloran, Lu, Williams, Ding, & Meyer, 2016; Yuen & Tarrant, 2014).

Despite these recommendations, influenza and Tdap vaccination rates remained lower than current goals among adults in the United States. Current national influenza vaccination goals were 70% while current estimations suggest only 38% of the total United States of America population receives the vaccination annually (HealthyPeople 2020, 2016). In recent studies of the 2013-2014 influenza season, among adults greater than 19 years, the influenza vaccination rate was 46.7%; and the rate was approximately 50% of pregnant women of all ages (Henninger, et al., 2015; Williams, et al., 2016). Age related discrepancies were also noted with individuals 65 years or older receiving the most vaccinations by percentage (Williams, et al.,

2016). In addition, racial disparities existed with whites receiving significantly more vaccines than blacks, Hispanics, and Asians (Williams, et al., 2016).

Similar to influenza vaccination rates, Tdap vaccination rates have remained consistently low among adults in the United States despite increased focus on vaccinating all adults in order to protect infants (under 1 year) and meet the Healthy 2020 (2016) goal to reduce pertussis among infants by at least 10%. Among individuals >19 years, 62.2% received any tetanus toxoid vaccination in the past 10 years and 20.1% received a Tdap vaccination in the past 9 years (Lu, O'Halloran, Ding, Liang, & Williams, 2016). In addition, 14% of pregnant women received the Tdap vaccine during their pregnancy (Kharbanda, et al., 2016). Adults aged 19-64 years old were more likely to receive a Tdap vaccine than any other age group (Williams, et al., 2016). Similar to influenza vaccination, whites were more likely to receive Tdap vaccination than blacks, Hispanics, and Asians (Williams, et al., 2016).

Problem Statement

While the current data offered some evidence about adult immunization rates, limited studies were available focusing on influenza and Tdap vaccination rates among childbearing-aged women (18-44 years). Understanding influenza and Tdap vaccination rates among childbearing-aged woman was needed as pregnant women and infants suffered greater health consequences from both influenza and pertussis (Kharbanda, et al., 2016; Lu, et al., 2016). Following current vaccination recommendations would greatly reduce the risk of respiratory illness among pregnant women, preterm birth, small-for-gestational age birth, and respiratory illness and subsequent hospitalization for pregnant women and infants less than 6 months of age (Baxter, Bartlett, Fireman, Lewis, & Klein, 2017; O'Leary, et al., 2015; Rosenbaum, McBane, Wang, & Sawyer, 2014). In addition, cocooning infants by vaccinating all individuals in close

proximity of the infant with influenza and Tdap vaccines provides a protective effect to infants (O'Leary, et al., 2015). Despite these facts, the reported influenza and Tdap vaccination rates remained below national standards set by HealthyPeople 2020 (2016). Additionally, limited information was available regarding influenza and Tdap vaccination rates among childbearing-aged women, as most studies focus on all adults and do not further describe the vaccination rates among this population by pregnancy status, age groups based on advanced maternal age, or racial/ethnic groups.

Purpose

In the United States, slightly more than 6.3 million pregnancies occurred annually with 49% of these pregnancies being unintended (CDC 2015d; CDC, 2016a). Since the current recommendations encouraged childbearing-aged women to maintain up-to-date vaccinations in case a pregnancy occurs, an analysis of influenza and Tdap vaccination rates among childbearing-aged women could aid in intervention development with the goal to improve vaccination coverage and health utilization in this population. One national database collecting relevant data about influenza and Tdap vaccination rates was the Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS could be sorted by many different factors including gender, race/ethnicity, location, etc. Therefore, through an analysis of a national database, researchers could identify demographic subsets among childbearing-aged women with low influenza and Tdap vaccination rates to develop and implement targeted interventions to improve vaccination among these high-risk groups. Thus, the purpose of this project was to assess influenza and Tdap vaccination rates among childbearing-aged women (18-44 years) by pregnancy status (pregnant versus non-pregnant), age group (18-34 years and 35-44 years), and race/ethnicity group (white, black, Hispanic, Asian).

Specific Aims

Within the 2014 Behavioral Risk Factor Surveillance System (BRFSS):

1. Identify and compare influenza and Tdap vaccination rates among childbearing-aged women who were pregnant and those who were not.
2. Identify and compare influenza and Tdap vaccination rates among childbearing-aged women by age group.
3. Identify and compare influenza and Tdap vaccination rates among childbearing-aged women by race/ethnicity.

Hypothesis

Among a nationally representative sample of childbearing-aged women:

1. There is a difference in influenza vaccination rates among women who are pregnant and those who are not.
2. There is a difference in Tdap vaccination rates between women who are pregnant and those who are not.
3. There is a difference in influenza vaccination rates between women who were 18-34 years and those who were 35-44 years.
4. There is a difference in Tdap vaccination rates between women who were 18-34 years and those who were 35-44 years.
5. There is a difference in influenza vaccination rates among whites, blacks, Hispanics, and Asians.
6. There is a difference in Tdap vaccination rates among whites, blacks, Hispanics, Asians.

Significance

Among all individuals living in the United States, each year approximately 5-20% contracts influenza (Molinari, et al., 2007). In 2014, pertussis cases reached an all time high of 32,974 incident cases (CDC, 2016b). In 2015, there were 20,762 per 100,000 incident cases reported by the CDC (2017) and suggested the rates of pertussis were improving with increased vaccination rates. These infections, if occurred among pregnant women, can cause serious consequence for these women and their infants. Specific influenza consequences among pregnant women included pneumonia, increased mortality in the third trimester, and increased risk of hospitalization from cardiorespiratory illness (Fortner, Kuller, Rhee, & Edwards, 2012; Yuen & Tarrant, 2014). Consequences seen among fetuses and infants born to mothers with influenza included greater likelihood of small for gestational age, increased mortality, increased teratogenic effects, such as cleft lip and palate, neural tube defects and cardiovascular malformations, and increased risk for schizophrenia (Yuen & Tarrant, 2014). Regarding pertussis, young infants were at greatest risk for severe disease complications such as apnea, pneumonia, seizures, and death (Gall, 2012; Suryadevara & Domachowske, 2015). Adults' disease related symptoms include protracted coughing illness with subconjunctival hemorrhages, weight loss, urinary incontinence, syncope, and rib fractures (Suryadevara & Domachowske, 2015). Therefore, it is imperative to find ways to improve influenza and Tdap vaccination rates among childbearing-aged women and women who are pregnant to prevent negative consequences of contracting the disease.

Limited information had been previously published regarding influenza and Tdap vaccination rates among childbearing-aged women. Influenza and Tdap vaccination rates among childbearing-aged women need to increase to meet Healthy 2020 goals. Therefore, an analysis of

the 2014 BRFSS vaccination data among childbearing-aged women offered a broad perspective of vaccination coverage in this population via analysis of a large national database.

Previous quality improvement projects have demonstrated increases in overall vaccination rates through a multi-component design (Fu, et al., 2012; Lam, George, Dunlow, Nelson, & Hartzell, 2013). Yet, to design targeted interventions, baseline data are needed. The results from this study could provide nursing professionals with an improved understanding of vaccination status in pregnant women as well as childbearing-aged women. In addition, the data could assist them to identify high-risk groups in need of additional intervention to improve influenza and Tdap vaccination rates. This would enable them to develop targeted interventions and/or quality improvement projects to improve vaccination rates and improve herd immunity for this crucial population.

Literature Review Criteria

Peer-reviewed published articles were identified through MESH terms and keyword searches from 2012 to present in the following databases: MEDLINE, SCOPUS, and CINAHL. MESH terms used in conjunction with Boolean connectors included “women,” “influenza,” “Tdap,” “vaccination,” and “immunization.” Other keywords used included pregnancy, pregnant, race, racial disparity, age, and age disparity. Reference lists of identified articles were also searched for relevant peer-reviewed articles. Articles were included for review if they were written in English, published between 2012-2016, studied a population in the United States, or were a review article. Of the 357 articles identified, 20 were relevant and were included in this discussion.

Literature Review

Annually, ACIP assessed the adult immunization schedule and provided new recommendations and changes as necessary (Annunziata, et al., 2012; Lu, et al., 2015b; Lu, O'Halloran, & Williams, 2015a). In recent years, several notable changes have been made for one specific population, childbearing-aged women. In particular, recommendations for two vaccinations, influenza and Tdap, have changed in the past 12 years. Current recommendations suggested all adults to receive an annual influenza vaccination in the fall of each year (Williams, et al., 2016). To further clarify the recommendation, ACIP recommended an annual influenza vaccination for all pregnant women during any trimester in 2004 (Rasmussen, Watson, Kennedy, Broder, & Jamieson, 2014). In 2005, ACIP recommended women of childbearing age receive a Tdap vaccination as a one-time replacement for tetanus & diphtheria (Td) vaccination prior to conception (Kharbanda, et al., 2016; Rasmussen, et al., 2014). In 2012, an ACIP committee met and updated the Tdap recommendation to prevent pertussis outbreaks in children < 1 year. In February 2013, the committee published the recommendation for all women to receive a Tdap vaccination during every pregnancy, ideally during the third trimester greater than two weeks prior to delivery (27-36 weeks gestation), even if the last Tdap or Td vaccination was given in the past 10 years (Fortner, et al., 2012, Kharbanda, et al., 2016; Rasmussen, et al., 2014). Since these recommendations were effective right after their release, data collected after 2013 should reflect the 2013 Tdap recommendation change to vaccinate all pregnant women during the 3rd trimester.

In recent years, safety of both influenza and Tdap vaccinations were studied among pregnant women 14-49 years and found to be safe and without significant consequences (DeSilva, Vazquez-Benitez, & Nordin, 2016; Sukumaran, et al., 2015; Wortman, Casey, McIntire, & Sheffield, 2015). In addition, one study found vaccinating mother during 27-36

weeks gestation was 85% more effective in preventing pertussis in infants less than 8 weeks old than when the vaccination was given at any other point during the pregnancy (Winter, Nickell, Powell, & Harriman, 2016).

Pregnant and non-pregnant women

Only a few studies have assessed influenza and Tdap vaccination rates among childbearing-aged women. In 2012, Fortner, et al., identified influenza vaccination rates among pregnant women for the 2009-2010 influenza season as a range between 32%-64%. Koepke, et al. (2015) analyzed data collected from January 2013 to March 2014, among 40,054 pregnant women (11-44 years) in Wisconsin and found overall influenza vaccination rates to be 38.7% during the study period with significant variations of influenza vaccination uptake noted among women who delivered in and out of influenza season. When studying postpartum women, O'Leary, et al. (2015) found a 50.5% influenza vaccination rate among 613 postpartum women in 2013. (O'Leary, et al., 2015). All those rates were below the goal of 70% set by HealthyPeople 2020 (Healthy People, 2016).

Vaccination rates of non-pregnant childbearing-aged women are very limited. Annunziata, et al. (2012) examined five years of the National Health and Wellness Survey (2007 to 2011) that included 25,000 adults (> 19 years) and found influenza vaccination rate was 54.5%. In another study of 12,657 childbearing women during the 2010 to 2011 influenza season, Kharbanda et al. (2013) found the influenza vaccination rate to be 39.8% but did not differentiate rates by pregnancy status. While these studies provided some basic information, the current influenza vaccination rate among childbearing-aged women is not available. Moreover, none of the studies have compared influenza vaccination rates between pregnant and non-pregnant women using the same data set collected from a nationally representative sample during the same time period.

Therefore, an assessment of influenza vaccination rates among pregnant versus non-pregnant was warranted.

Similar to influenza vaccination rates, minimal information on Tdap vaccination rates among childbearing-aged women were available. From December 2010 to April 2011, Lam and associates conducted a performance improvement project which included 3,185 women who were of childbearing age or had frequent exposure with children treated by gynecologists at a large military treatment facility. The authors found the Tdap vaccination rate was 13.9% during the study period (Lam, et al., 2013). One reason for the observed low rate could be that this study was conducted before the new recommendation issued by ACIP in 2013. . In another study, Lu, et al. (2016) analyzed the 2013 BRFSS data and found the overall Tdap vaccination rate among 479,201 adults was 28.9%; and a rate of 51.3% for adult female participants. The authors did not report the rate for childbearing-aged women or for pregnant women. Using data collected in 2011, another study found Tdap vaccination rates among 12,657 childbearing-aged women to be 45.5% (Kharbanda, et al., 2013). One study found significant increases (from 14% to 41.7%) in Tdap vaccination among 438,487 pregnant women after the most recent ACIP's recommendation change (Kharbanda, et al., 2016). However, they did not report whether there was similar increases among non-pregnant women. Koepke, et al. (2015) assessed Tdap vaccination receipt among 40,054 pregnant women (11-44 years) in Wisconsin and found Tdap vaccination rates to be 35% in this study population. Among 613 postpartum women, Tdap vaccination receipt during pregnancy was 67% (O'Leary, et al., 2015). Finally, Suryadevara & Domachowske (2015) reported the Tdap vaccination rates as 17.2% for the general adult population in the United States in 2013.

Based on a review of the literature, gaps exist regarding national influenza and Tdap vaccination rates among pregnant and non-pregnant childbearing-aged women (18-44 years). Some studies reported data collected before the new ACIP recommendation (Azzunziata, et al., 2012; Fortner, et al., 2012; Kharbanda, et al., 2013; Lam, et al., 2013; Santibanez & Kennedy, 2016); while others used data from local or regional practices (Kharbanda, et al., 2016; Koepke, et al., 2015; O'Leary, et al., 2015). Only one study reviewed national database information and identified Tdap vaccination rates of childbearing aged women (Azzunziata, et al., 2012). Additionally, limited data is available regarding influenza and Tdap vaccination rates among non-pregnant childbearing-aged women. Furthermore, none of the studies have compared the vaccination rates between childbearing-aged women who were pregnant or not pregnant using a nationally representative sample. Therefore, an analysis regarding influenza and Tdap vaccination rates of pregnant and non-pregnant childbearing aged women in a nationally representative sample is warranted to identify high-risk groups in need of intervention to improve influenza and Tdap vaccination rates.

Age group differences

The majority of information available regarding influenza and Tdap vaccination rates are lumped into large age groups, such as ≥ 18 years old, ≥ 19 years old, ≥ 65 years old, etc. For example, Groom, Zhang, Fisher, & Wortley (2014) reported influenza vaccination rates among 3,138 adults as 68% for white adults greater than 65 years old and 54% for black adults greater than 65 years old, but did not stratify by gender or include women less than 65 years old. In a study of 34,535 adults, the authors found significant differences among age groups of all adults ≥ 18 years, with those greater than or equal to 65 years receiving more influenza vaccinations than those younger than 65 years ($p<0.05$) (Lu, et al., 2015b). Several studies identified statistically

significant differences among multiple age groups of adults who received the influenza and Tdap vaccinations. Kharbanda, et al., (2013) assessed Tdap vaccination rates among 12,657 adult women and found significant differences among vaccination frequencies by age groups: 18-26 years (reference group), 27-35 (45.6%, $p<0.0002$), and 36-44 years (43.2%, $p<0.0001$). Another study assessing only Tdap vaccination rates among the United States adult population found that 18-49 years and 50-64 years age groups to be significantly more likely to receive the Tdap vaccination then those ≥ 65 years ($p<0.05$) (Lu, et al., 2016). Williams, et al. (2016) assessed national vaccination rates and identified significant age group differences for both influenza and Tdap vaccination rates. For influenza, vaccination rates were significantly higher among 50-64 years and ≥ 65 years ($p<0.05$) (Williams, et al., 2016). Tdap vaccination rates were significantly lower among those ≥ 65 years when compared to 19-49 years and 50-64 years age groups ($p<0.05$) (Williams, et al., 2016).

Among these studies comparing vaccination rates among age groups, only one compared age groups among women of childbearing age (Kharbanda, et al., 2013). The data collected was from January 1, 2007 – March 31, 2011. There were no current studies that have compared vaccination rates among age groups for this study population.

Race/ethnicity differences

Often racial disparities were noted in scientific research. A review of the literature suggested four major racial groups most likely to receive both influenza and Tdap vaccinations were whites, blacks, Hispanics, and Asians. Among 12,657 women, Kharbanda, et al. (2013), found a statistically significant difference regarding influenza vaccination rates only among blacks (30.0%, $p=0.0001$) when compared to non-Hispanic whites (40.7%, reference). Influenza vaccination rates were not statistically significant among Hispanics (46.1%, $p=0.59$) and Asians

(41.1%, p=0.81) when compared to white, non-Hispanics. Additionally, the authors found Asians were less likely (78.3%, p=0.0003) to receive a Tdap vaccine than whites (82.9%, reference category), black (84.4%, p=0.26), and Hispanics (81.7%, p=0.5755). Several studies identified whites as more likely to receive both influenza and Tdap vaccines than blacks, Hispanics and Asians. Lu, et al. (2015b) found significant differences by race and age group for both influenza and tetanus/Tdap vaccinations in a sample of 479,201 adults from the 2013 BRFSS dataset. Regarding influenza vaccination rates, non-Hispanic blacks aged 19-64 years (Adjusted Prevalence Ratio (APR)=0.92, $p<0.05$) and non-Hispanic Asians aged 19-64 years (APR=1.24, $p<0.05$) were less likely to receive the vaccine than whites (reference) and Hispanics of all ages (APR=1.07, $p<0.05$) (Lu, et al., 2015). Regarding Tdap vaccination rates, non-Hispanic blacks aged 19-64 years (APR=0.84, $p<0.05$), Asians aged 19-64 years (APR=0.84, $p<0.05$), and Hispanics aged 19-64 years (APR=0.91, $p<0.05$) were less likely to receive Tetanus/Tdap vaccines than non-Hispanic whites (Lu, et al., 2015). Williams, et al. (2016) also identified significant race/ethnicity differences for both influenza and Tdap vaccination rates among all adults (>=18 years). When compared to white, non-Hispanic adults (46.7%), blacks (36.5%, $p<0.05$) and Hispanics (33.2%, $p<0.05$) were less likely to receive an influenza vaccine and there was no significant difference among Asians (44.6%) (Williams, et al., 2016). When compared to white, non-Hispanic adults (46.7%), blacks (50.7%, $p<0.05$), Asians (50.5%, $p<0.05$), and Hispanics (52.1%, $p<0.05$) were less likely to receive a tetanus/Tdap vaccination (Williams, et al., 2016). With disparities noted among vaccine receipt among all adults, an assessment of race/ethnicity regarding receipt of influenza and Tdap vaccinations among childbearing-aged women was needed to add to the body of literature.

This literature review showed gaps concerning influenza and Tdap vaccination rates among childbearing-aged women. Both vaccination rates have not been systematically compared between pregnant and non-pregnant women and by age groups, using a nationally representative sample. Therefore, additional research is needed to identify current influenza and Tdap vaccination rates among women of childbearing-aged women.

Theory

The theoretical model driving this study was Andersen's Behavioral Model of Medical Care Utilization (Andersen & Newman, 1973). The model was originally designed to understand health care utilization in an integrated framework by studying relationships between individuals, providers, and the societal or environmental determinants (Andersen & Newman, 1973). The authors discussed the importance of identifying and defining trends and relationships within national survey data to obtain further understanding of healthcare utilization (Andersen, 1995; Andersen & Newman, 1973). In order to understand an individual's use of services, there were three components to comprehend: predisposing factors, factors that contribute or impede use (enabling factors), and need for healthcare (illness level) (Heider, et al., 2014). Predisposing factors included socio-demographic factors such as race, age, education, income, etc. In addition to providing information regarding health care utilization, the trends and relationships also provided information to shape public policy and decision-making (Andersen & Newman, 1973).

Since the late 1960s, the model has been adapted and improved to adjust for changes in health care utilization and our health care system. Figure 1 describes the current model, Phase 4. The model outlined a feedback loop exhibiting multiple influences on health services and ultimately health status (Andersen, 1995). This study will evaluate trends and relationships among childbearing-aged women's use of health services (receipt of influenza and Tdap

vaccinations) allowing for an evaluation of health status (immunity to vaccine preventable disease), thus aligning with Phase 4 of Andersen's Health Utilization model. In addition, using specific demographic variables, such as age and race/ethnicity, will highlight particular groups who need additional intervention to improve vaccination rates; thus, increasing healthcare utilization.

Variables

Study variables were selected from the 2014 BRFSS database (Centers for Disease Control and Prevention (CDC), 2015a). The variable, PREGNANT, identified women who were pregnant and those who were not during the survey (CDC, 2015a). AGE was measured as years and divided into two age groups: 18-34 years and 35-44 years. This transformation was needed as women 35 years or older are considered as having advanced maternal age and may be considered higher risk for poor fetal outcomes. Race/ethnicity was measured by the variable _RACE, which considered both race and ethnicity (CDC, 2015b). All respondents who reported they were of Hispanic or Latino origin were listed as Hispanic (CDC, 2015b). Other racial groups included in this analysis were non-Hispanic white (white), non-Hispanic blacks (blacks), and non-Hispanic Asians (Asian). Demographic variables such as marital status (married/living with a partner versus not married), number of children less than 18 years old in household (CHILDREN), education (EDUCA), employment status (EMPLOY1), and income (INCOME2) were also included in this study (Appendix A). Finally, _STATE was used to identify which states utilized the TETANUS module. Appendix A outlined theoretical and operational definitions for all variables and Appendix B lists the codebook for this study. Concept maps for influenza and Tdap variables were located in Figures 2 & 3, respectively.

Methods

Research Design

This retrospective secondary data analysis used a descriptive-correlational design. There were two reasons for choosing this study. First, this design was a good fit to answer the proposed research hypotheses as national surveillance data provides a large study population and relevant BRFSS questions were asked to evaluate the research questions during the original telephone survey. Second, this design was realistic and feasible as it enabled the researcher to complete the study in the defined time period.

Setting & Sample

The 2014 BRFSS was a national health-related telephone survey of non-institutionalized adults ≥18 years old conducted annually in all 50 states and the District of Columbia regarding health risk behaviors, chronic disease, and use of preventative services (CDC, 2016a). Study participants were randomly chosen through a multistep cluster design (random digit dialing) with over 450,000 surveys completed annually (Lu, et al., 2016). The survey consisted of a core questionnaire required for all states, additional modules, and state specific questions. Each state had the option to include or exclude the additional modules. Therefore, not all of the additional modules were included for each state in the BRFSS. Since 2011, landline and cellular telephones were included in the BRFSS. The response rate for the 2014 BRFSS was 47% for both landlines and cell phones (CDC, 2015c).

After the survey has been compiled, the resulting annual databases were managed online in the public domain and were free and readily available for evaluation and analysis. In 2014, there were 464,664 total participants, with almost 59% of the participants identifying as female (CDC, 2015a). Since the data contained no identification and is in the public domain, this study

is considered a non-human subject study and exempt from IRB review (GWU IRB communication, 2016).

From the 2014 BRFSS data, all women aged 18 – 44 years were used in this analysis. The inclusion criterion includes all women (answered female to the BRFSS question "Indicate sex of respondent"), aged 18 years to 44 years, with race coded as white, black, Hispanic, and Asian (CDC, 2015a; CDC, 2015b).

Sample Size

The 2014 BRFSS included 66,894 childbearing-aged women. We performed a power analysis to determine the sample size needed for our hypotheses. By assuming a small effect size, 50% rate versus 55% rate, with alpha of 0.05 and power of 0.80, the minimum sample size requirements were 1604 individuals per group for each research question (Biomath.com, n.d.). Due to the large sample in BRFSS, we anticipated that we would have enough respondents in each comparison group.

Instrument and Measurement

Initial data collection of the 2014 BRFSS occurred at the state level. Data was collected monthly and data collection varied slightly state by state, as there were state specific questions and state-selected modules. All interviewers received extensive training provided via a CDC standardized protocol. Data was collected via computer software, WinCATI (Windows-based Computer Assisted Telephone Interviewing). Each interview was conducted following a computerized script and read verbatim. The interview selected the respondent's answer and the computer generated the skip pattern, as necessary. Through the design of the software and by incorporating edits and skip patterns into the WinCATI instrument, interviewer errors, data entry

errors, and skip errors were reduced (Alaska Department of Health and Social Services, 2016). In addition, data was cleaned prior to being made publicly available on the CDC's website.

The validity and reliability of the BRFSS questions have been widely studied. Pierannunzi, Hu, & Balluz (2013) conducted a systematic review of the literature and found high validity and reliability among immunization and preventative testing. Burger & Reither (2014) found sensitivity of influenza vaccination receipt to be 92.9%. Therefore, the data used in this study was considered to be both valid and reliable.

The 2014 BRFSS database included all of the survey variables and calculated variables. We included selected demographic data to describe the study sample in detail, including age, race/ethnicity, marital status, number of children in household, education, employment status, and income. In order to answer the research questions, the following BRFSS questions were used:

- Pregnancy status: "To your knowledge, are you now pregnant?" (CDC, 2015a)
- Influenza vaccination receipt: "During the past 12 months, have you had either a flu shot or a flu vaccine that was sprayed in your nose?" (CDC, 2015a)
- Tdap vaccination receipt: "Since 2005, have you had a tetanus shot? (If yes, ask, "Was the Tdap, the tetanus shot that also has pertussis or whooping cough vaccine?") (CDC, 2015a)

The variable TETANUS was included in the 2014 BRFSS additional modules. Since states were allowed to choose whether the module was included or not, TETANUS module was only selected for use in the following states in 2014: Georgia, Mississippi, Rhode Island, Tennessee, Vermont, and Virginia.

Data Analysis

The 2014 BRFSS database was downloaded into SPSS version 23. The study sample was selected using the eligibility criteria. Descriptive statistical analysis was performed on each study variable. Since all variables were categorical, frequencies and percentages were calculated (Table 1). Chi-squared analysis was used to address the research hypotheses.

Prior to data analysis, multiple variables were transformed. Age was recoded as 18-34 years and 35-44 years. TETANUS were transformed to combine “Yes, received Tdap” and “Yes, received tetanus shot but not sure what type” to Yes and “No, did not receive any tetanus since 2005” was no and “Yes, received tetanus, but not Tdap” was coded as missing. For all analyses, alpha was set at 0.01 to account for the large sample size.

Ethical Considerations

The George Washington University’s Institutional Review Board determined this was a non-human subject study and was exempt from IRB review (GWU IRB communication, 2016).

Results

The 2014 BRFSS included 66,894 childbearing-aged women**.** Of the women in the sample, 60.0% were married and 68.9% had children living in the household. Most women (70.0%) completed more than high school and were employed outside of the home (64.8%), with 58.8% of women having a total household income greater than $35,001 annually. Only 3.8% of the 66,894 childbearing-aged women were pregnant during the 2014 BRFSS data collection. Most of the women were 18 to 34 years (53.6%) and were largely white, non-Hispanic (70.4%). Thirty-seven percent of the sample population received an influenza vaccination. Of the 3,861 women who were asked and answered the Tdap question, 59.0% received the Tdap vaccination since 2005. Table 1 outlines demographics of the sample.

Demographic variables are usually considered in all studies as they often are confounding variables for results. The association between marital status, living with children, income and education provide important information about variables that could be influential to immunization. Although these are not the primary variables in this study, we feel they should be included in the results and discussion. Among women who were married or living with a partner, 39.8% received an influenza vaccination while 32.1% of women who were not married received an influenza vaccination (X^2=382.28, p<0.001). Similarly, 38.2% of women who had children living in the household received the vaccination while 33.3% who did not have children received the vaccination (X^2=140.39, p<0.001). Among women who earned more than $75,000, 46.8% received an influenza vaccination in the past year (X^2=1173.87, p<0.001). Table 2 outlines additional demographic characteristics by influenza vaccination status.

Similarly, an analysis of demographic characteristics by Tdap vaccination receipt revealed several significant variables. Martial status and children living in household variables were not found to be significant predictors of receipt of Tdap vaccination. Education (X^2=41.28, p<0.001), employment status (X^2=8.51, p=0.004), and income (X^2=40.99, p<0.001) were found to be statistically significant predictors of Tdap vaccination receipt. Table 3 outlines the results of this analysis.

X^2 tests were used to evaluate the hypotheses. Among women who were pregnant, 43.1% received an influenza vaccination while the rate was 36.5% among non-pregnant women of child-bearing age (X^2=43.69, p<0.001). By age group, the influenza vaccination rate was 35.1% in past year for women who were 18-34 years old while the rate was 38.5% among women who were 35-44 years old (X^2=288.47, p<0.001). There was also significant differences among racial/ethnic groups, with 30.5% of black, 31.6% of Hispanic, 38.8% of white, and 41.0% of

Asian women received an influenza vaccination in the past 12 months (X^2 = 288.47, p<0.001). Table 4 outlines the results of this analysis.

For Tdap vaccination, pregnancy status was not significant at the 0.01 level. For childbearing-aged women who were pregnant, 68.3% received the vaccine while for women who were not pregnant, the rate was 58.6% (X^2=5.28, p=0.022). Age was significant. For women who were 18-34 years old, 61.3% had received the vaccine since 2005; while women who were 35-44 years old 56.8% received the vaccine (X^2=8.15, p=0.004). Among the racial/ethnicity groups, 45.3% of black women, 48.5% of Asian women, 53.3% of Hispanic woman, and 63.3% of white women received a Tdap vaccination since 2005 (X^2 = 84.93, p<0.001). Table 5 outlines the results of this analysis.

Discussion

In alignment with previously reported influenza and Tdap vaccination rates among all adults, this study found the vaccination rates among childbearing-aged women were 36.7% for influenza and 59.0% for Tdap. These rates were below the national goals of 70% for influenza vaccination as defined by Healthy people 2020 (2016). HealthyPeople 2020 has not outlined a national Tdap vaccination goal at this time, but does have a goal to reduce infant pertussis cases (2016).

In this study, we found that women who were married or living with a partner received the influenza vaccination 7.7% more than those who were not married and 4.9% more if they had children living in their home versus no children living at home. Some possible reasons for these results may be partners are more likely to obtain vaccinations together, receive vaccination through their workplace, or increased home pressure to receive vaccinations to prevent disease in the home. Individuals living with children in the home may be more likely to receive an

influenza vaccination due to the potential health risk of influenza for children. However, after a review of the literature, no other studies identified marital status or children living in the home as predictors of influenza vaccination receipt.

The largest demographic discrepancies were noted among education and income. Those with more than high school education were 11.3% more likely to receive an influenza vaccine than those who had less than high school education. Similarly, those with a household income over $75,000 were 16.8% more likely to receive an influenza vaccination than those who made less than $35,000 annual household income. Therefore, interventions to improve vaccination rates should focus on providers and less educated, lower income childbearing-aged women to improve overall vaccination rates and reduce disease burden and costs.

Further review of our results, suggests pregnancy status improves influenza vaccination rates and aligns with findings from other studies (Kharbanda, et al., 2013). The reason for this higher rate could be due to increased doctor's appointments during pregnancy and frequent reminders by healthcare providers to receive vaccination (Lu, et al., 2015). In addition, women who were older (35-44 year old) were more likely to have received the influenza vaccine than their younger counterpart (18-34 year old). This finding is consistent with the literature in that older adults had higher rates of receiving this vaccine than younger adults (Lu, et al., 2015). This suggests that the increasing rates of influenza vaccination may be linear with growing age, regardless of age groups.

The greatest discrepancies noted were among racial categories with non-Hispanic blacks receiving the vaccination 10.5% less than Asians. The disparities identified may highlight different patient beliefs and practices regarding preventative medicine. Kharbanda, et al. (2013)

also suggested the lower influenza vaccination coverage among non-Hispanic blacks may be due to a greater mistrust in the modern medical system.

For Tdap vaccination, the largest demographic discrepancy was noted among education. Those with more than high school education were 18.2% more likely to receive a Tdap vaccine than those who had less than high school education. While the differences were not as large, income and employment status varied as well. Women with an annual household income of $75,000 or more were 12.6% more likely to receive a Tdap vaccination than those who had a household income of $35,000. Women employed outside of the home were 5% more likely to receive a Tdap vaccination than those who were not employed. As with influenza vaccination, interventions to improve Tdap vaccination rates should focus on providers and less educated, lower income childbearing-aged women to improve overall Tdap vaccination rates and reduce disease burden and costs.

Pregnancy status was not found to be a significant predictor for receipt of Tdap vaccination in this study. This result does not align with other findings of similar studies, which found pregnancy status to increase Tdap vaccination rates (Kharbanda, 2013; O'Halloran, et al., 2016). One of the reasons for the discrepancy could be a small sample size since Tdap vaccination questions were only asked in six states, rather than all 50 states and the District of Columbia. For age, 18-34 year old women were 4.5% more likely to receive a Tdap vaccination than women who were 35-44 years old. A portion of this discrepancy may be accounted for by the large number of individuals who would have received this vaccination while under 18 years old in order to attend school or participate in sports (O'Halloran, et al., 2016). Finally, there was an 18% gap between white and black childbearing-aged women regarding receipt of Tdap vaccination. Again, the discrepancy may be accounted for by an overall distrust in the modern

medical system or a lack of patient education regarding need of vaccination (Kharbanda, 2013; O'Halloran, et al., 2016). Therefore, differences were only noted among childbearing-aged women by age group and race, not by pregnancy status.

Limitations

Several limitations of this study should be noted. Since this was a secondary data analysis, the researchers were limited by the parameters of previously collected data. Second, since influenza and Tdap vaccination status were self-reported, recall bias may have affected results. Third, since the Tdap questions were state-selected questions, with participation from only six states, the sample size for Tdap vaccines was noticeable smaller than the influenza vaccination and the results may not be generalizable to the general population. In addition, some women were excluded from the analysis due to their inability to clearly identify whether they had received Tdap or Td vaccination. Finally, the smaller sample size of pregnant women regarding Tdap vaccination rates may also account for why pregnancy status did not have a significant result.

Implications/Recommendations

Despite the limitations, this study reveals important information about influenza and Tdap vaccination rates among childbearing-aged women. The findings suggest a need for targeted interventions to improve influenza and Tdap vaccination rates among childbearing-aged women due to the potential complications from both influenza and pertussis to pregnant women and young children (Fortner, et al., 2012; Suryadevara & Domachowske, 2015; Yuen & Tarrant, 2014). With recent guideline changes to improve influenza and Tdap vaccination rates among childbearing-aged women, Tdap vaccination rates should continue to rise. However, an increase in Tdap vaccination rates will only occur if patients understand the need for the vaccine and

receive vaccinations per current recommendations. Therefore, nurse practitioners, physician assistants, and physicians must work together to improve awareness within their patient populations. Therefore, interventions designed to improve vaccination rates need to target both providers and high-risk patient populations. Provider interventions to consider for further testing may include raising awareness of current vaccine recommendations for childbearing-aged women among providers, a reminder prompt in the patient's medical record to document current vaccination status, include questions about last vaccination of influenza and Tdap/Td on patient intake forms, or a conversation starter tool to aid providers with conversations about vaccination status. Patient interventions to consider for further study may include hanging flyers in locations where childbearing-aged women are likely to be (grocery stores, gym, daycares, workplaces, shopping malls/stores, etc.), working with local community health departments to assess vaccination status in their communities, or collaborating with places of employment/health plans to promote vaccination receipt. Increasing influenza and Tdap vaccinations improves healthcare utilization and satisfies Andersen's Behavioral Model of Medical Care Utilization.

Therefore, further studies are needed to fully understand why vaccination rates were below current HealthyPeople 2020 goals and what interventions are effective in improving influenza and Tdap vaccination rates among childbearing-aged women. Additional research regarding disparities among the demographic variables may provide more information to aid in intervention design. Ultimately, through tested interventions, influenza and Tdap vaccination rates will improve and reduce the burden and costs associated with influenza and pertussis among childbearing-aged women, fetuses, infants, and children.

Conclusions

While this study analyzed influenza and Tdap vaccination rates among childbearing aged women within a large national database, further research is needed to better understand identified discrepancies. In addition, the results of this study should be compared with similar national vaccination databases in order to obtain a more complete picture of vaccination rates among childbearing-aged women. Finally, interventions should be designed to target providers as well as higher-risk groups, such as, lower income, less educated, non-Hispanic blacks, to improve overall influenza and Tdap vaccination rates.

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Table 1

Demographics of the Sample (N=66,894)

Demographic Variable	Frequency	Percentage
Marital status (n=66,386)		
Married or living with partner	39,814	60.0%
Not married	26,572	40.0%
Children in household (n=66,359)		
Children living in the household	45,751	68.9%
No children living in the household	20,608	31.1%
Education (n=66,389)		
Less than high school	4,984	7.5%
High school graduate	14,950	22.5%
More than high school	46,455	70.0%
Employment Status (n=66,146)		
Employed outside the home	42,889	64.8%
Not employed	23,257	35.2%
Income (n=58,059)		
Less than $35,000	23,901	41.2%
$35,001 to $75,000	16,340	28.1%
More than $75,000	17,818	30.7%
Pregnancy Status (n=64,575)		
Yes, currently pregnant	2,472	3.8%
Not currently pregnant	62,103	96.2%
Age (n=66,646)		
18 to 34 years	35,691	53.6%
35 to 44 years	30,955	46.4%
Race (n=61,917)		
White, non-Hispanic	43,581	70.4%
Black, non-Hispanic	6,563	10.6%
Asian	2,193	3.5%
Hispanic	9,580	15.5%
Influenza Vaccination (n=62,752)		
Yes, received influenza vaccination in past 12 mo	23,029	36.7%
No, did not receive influenza vaccination in past 12 mo	39,723	59.4%
Tdap Vaccination (n=3,861)		
Yes, received Tdap since 2005	2,278	59.0%
No, did not receive Tdap since 2005	1,583	41.0%

Table 2

Comparison of Influenza vaccination by Demographic Characteristics

	Influenza vaccination		X^2	P-value
	No	Yes		
Marital status (n=62492)			382.28	p<0.001
Married or living with partner	22,686 (60.2%)	14,985 (39.8 %)		
Not married	16,860 (67.9%)	7,961 (32.1%)		
Children in household (n=62559)			140.39	p<0.001
Children living in the household	26,630 (61.8%)	16,474 (38.2%)		
No children living in the household	12,979 (66.7%)	6,474 (33.3%)		
Education (n=62656)			652.26	p<0.001
Less than high school	3,256 (71.4%)	1,304 (28.6%)		
High school graduate	9,848 (70.7%)	4,077 (29.3%)		
More than high school	26,552 (60.1%)	17,619 (39.9%)		
Employment Status (n=62542)			218.10	p<0.001
Employed outside the home	24,824 (61.2%)	15,728 (38.8%)		
Not employed	14,772 (67.2%)	7,218 (32.8%)		
Income (n=55434)			1173.87	p<0.001
Less than $35,000	15,772 (70.0%)	6,769 (30.0%)		
$35,001 to $75,000	9,797 (62.5%)	5,889 (37.5%)		
More than $75,000	9,153 (53.2%)	8,054 (46.8%)		

Table 3

Comparison of Tdap Vaccination by Demographic Characteristics

	Tdap vaccination		X^2	P-value
	No	Yes		
Marital status (n=3844)			5.20	p=0.023
Married or living with partner	876 (39.5%)	1,343 (60.5%)		
Not married	701 (43.1%)	924 (56.9%)		
Children in household (n=3850)			1.24	P=0.265
Children living in the household	1,108 (41.6%)	1,557 (58.4%)		
No children living in the household	470 (39.7%)	715 (60.3%)		
Education (n=3855)			41.38	p<0.001
Less than high school	147 (56.3%)	114 (43.7%)		
High school graduate	404 (45.2%)	489 (54.8%)		
More than high school	1,029 (38.1%)	1,672 (61.9%)		
Employment Status (n=3853)			8.51	p=0.004
Employed outside the home	1,032 (39.4%)	1,586 (60.6%)		
Not employed	548 (44.4%)	687 (55.6%)		
Income (n=3454)			40.99	p<0.001
Less than $35,000	662 (47.0%)	748 (53.0%)		
$35,001 to $75,000	385 (39.6%)	588 (60.4%)		
More than $75,000	368 (34.4%)	703 (65.6%)		

Table 4

Comparison of Influenza Vaccination Rate by Pregnancy, Age, and Race/Ethnicity

	Influenza vaccination		X^2	P-value
	No	Yes		
Pregnant (n=62507)			43.69	p<0.001
Yes	1,369 (56.9%)	1,036 (43.1%)		
No	38,194 (63.5%)	21,908 (36.5%)		
Age in years (n=62560)			75.77	p<0.001
18-34	21,639 (64.9%)	11,710 (35.1%)		
35-44	17,972 (61.5%)	11,239 (38.5%)		
Race/Ethnicity (n=58186)			288.47	p<0.001
White	25,416 (61.2%)	16,083 (38.8%)		
Black	4,220 (69.5%)	1,848 (30.5%)		
Asian	1,147 (59.0%)	798 (41.0%)		
Hispanic	5,933 (68.4%)	2,741 (31.6%)		

Table 5

Comparison of Tdap Vaccination Rate by Pregnancy, Age, and Race/Ethnicity

	Tdap vaccination		X^2	P-value
	No	Yes		
Pregnant (n=3854)			5.28	p=0.022
Yes	45 (31.7%)	97 (68.3%)		
No	1,535 (41.4%)	2,177 (58.6%)		
Age in years (n-3854)			8.15	p=0.004
18-34	736 (38.7%)	1,168 (61.3%)		
35-44	842 (43.2%)	1,108 (56.8%)		
Race/Ethnicity (n=3711)			84.93	p<0.001
White	964 (36.7%)	1,663 (63.3%)		
Black	417 (54.7%)	346 (45.3%)		
Asian	34 (51.5%)	32 (48.5%)		
Hispanic	119 (46.7%)	136 (53.3%)		

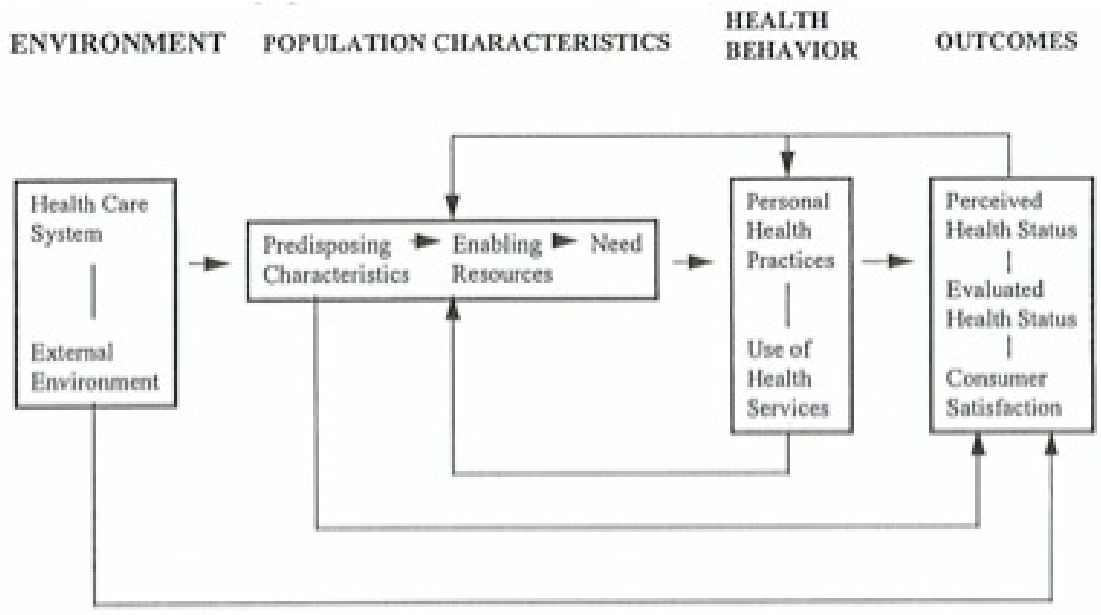

Figure 1. Andersen's Behavioral Model of Medical Care Utilization, Phase 4 (Andersen, 1995).

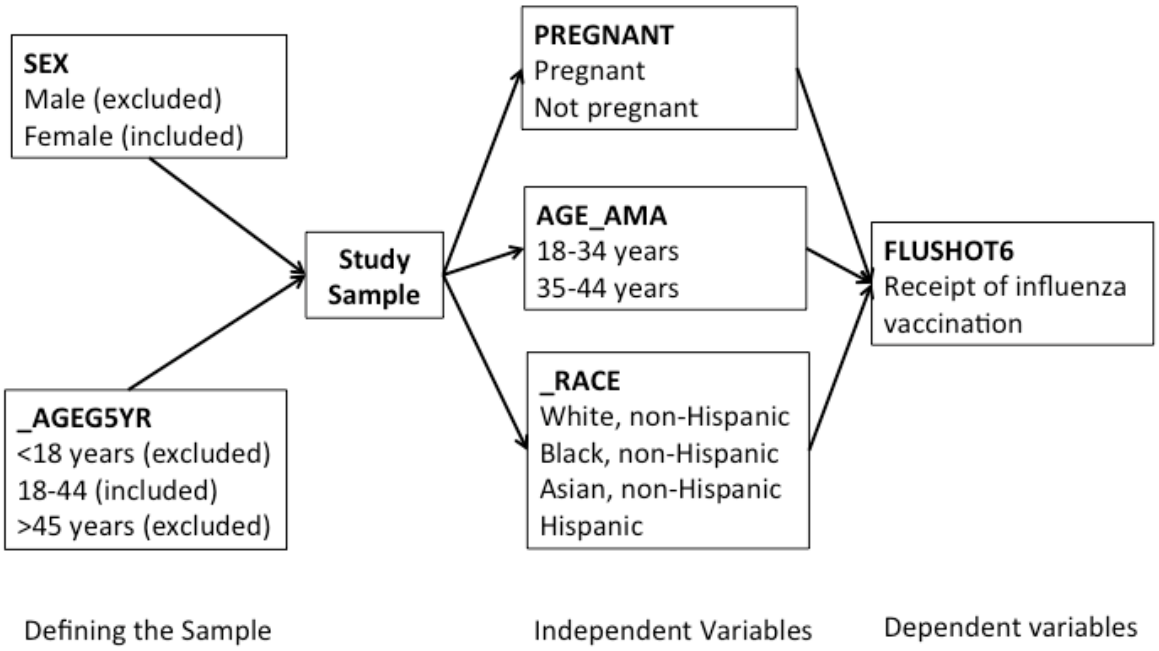

Figure 2. Concept map for dependent variable FLUSHOT6

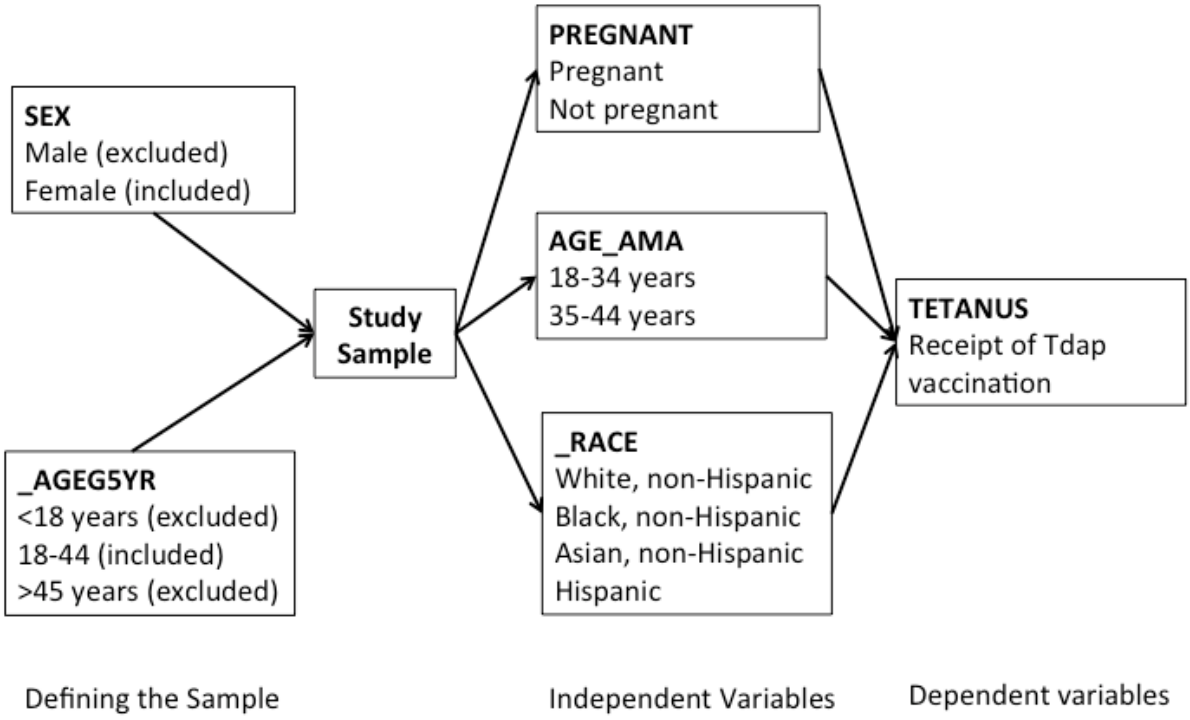

Figure 3. Concept map for dependent variable TETANUS

Appendix A

Variable names, Theoretical definitions, and Operational definitions

Variables	Theoretical definition	Operational definition
Dependent variables		
FLUSHOT6	Receipt of influenza vaccination (either shot or nasal mist) in past 12 months.	1 = Yes; 2 = No
TETANUS	Receipt of tetanus/Tdap vaccine	1 = Yes, received Tdap 2 = No, did not receive Tdap since 2005
Independent variables		
PREGNANT	Respondent's current pregnancy status	1 = Yes, currently pregnant 2 = Not currently pregnant
AGE_AMA	Transformed variable to create two age groups based on diagnosis of advanced maternal age	1 = 18 to 34 years 2 = 35 to 44 years
_RACE	A calculated variable to categorize race and ethnicity into groups.	Only categories included in this study are listed below: 1 = White only, non-Hispanic 2 = Black only, non-Hispanic 3 = Asian only, non-Hispanic 8 = Hispanic
Additional demographic variables		
MARITAL	Current marital status	1 = Married or living with partner 2 = Not married
CHILDREN	Dichotomous variable to assess presence or absence of children less than 18 years of age living in household	1= Children in the household 2 = No children in the household
EDUCA	Highest grade or year of school completed by respondent	0 = Less than high school 1 = High school graduate 2 = More than high school
EMPLOY1	Employment status	1 = Employed outside home 2 = Not employed
INCOME2	Annual household income from all sources	1 = Less than $35,000 2 = $35,001 to $75,000 3 = More than $75,000
Other variables		
_STATE	Identifies answers by state	Each state is listed alphabetically

Appendix B

Codebook

Dependent variables

FLUSHOT6
Section: 11.1 Immunization
Column: 202
Description: During the past 12 months, have you had either a flu shot or a flu vaccine that was sprayed in your nose?

Value	Value Label
1	Yes
2	No
7, 9, Blank	Missing

TETANUS
Module: 9.1
Column: 345
Description: Since 2005, have you had a tetanus shot? (If yes, ask “Was the Tdap, the tetanus shot that also has pertussis or whopping cough vaccine?”)

Value	Value Label
1	Yes, received Tdap
2	No, did not receive any tetanus since 2005
7, 9, Blank	Missing

Independent variables

PREGNANT
Section: 8.22
Column: 179
Description: To your knowledge, are you now pregnant?

Value	Value Label
1	Yes
2	No
7, 9, BLANK	Missing

_AGE5YR
Section: Demographics, calculated variables
Description: Calculated variable for fourteen-level age categories.

Value	Value Label
1	Age 18 to 34 years
2	Age 35 to 44 years

14, Blank	Missing

_RACE
Section: Demographics, calculated variables
Description: Calculated variable for race.

Value	Value Label
1	White, non-Hispanic
2	Blacks, non-Hispanic
4	Asian only, non-Hispanic
8	Hispanic
9, Blank	Missing

Demographic variables:

MARITAL
Section: 8.6
Column: 147
Description: Are you …?

Value	Value Label
1	Married or living with partner
2	Not married
9, BLANK	Missing

CHILDREN
Section: 8.7
Column: 148-149
Description: How many children less than 18 years of age live in your household?

Value	Value Label
1	Children living in household
2	No children living in household
99, BLANK	Missing

EDUCA
Section: 8.8
Column: 150
Description: What is the highest grade or year of school you completed?

Value	Value Label
0	Less than high school
1	High school graduate
2	More than high school
9, BLANK	Missing

EMPLOY1
Section: 8.9
Column: 151
Description: Are you currently…?

Value	Value Label
1	Employed outside of the home
2	Not employed
9, BLANK	Missing

INCOME2
Section: 8.10
Column: 152-153
Description: Is your annual household income from all sources:

Value	Value Label
1	Less than $35,000
2	$35,001 to $75,000
3	More than $75,000
77, 99, BLANK	Missing