8-2018

A Modern Plague: U.S. Racial and Ethnic Vaccination Disparities During the 2009 H1N1 Influenza Pandemic

Andrew E. Burger
Utah State University

A MODERN PLAGUE: U.S. RACIAL AND ETHNIC VACCINATION DISPARITIES DURING THE 2009 H1N1 INFLUENZA PANDEMIC

by

Andrew E. Burger

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Sociology

Approved:

_____	_____
Eric Reither Major Professor	Erin Hofmann Committee Member
_____	_____
So-Jung Lim Committee Member	Jacob Freeman Committee Member
_____	_____
Svenn-Erik Mamelund Committee Member	Richard Inouye, Ph.D. School of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

2018

ABSTRACT

A MODERN PLAGUE: U.S. RACIAL AND ETHNIC VACCINATION DISPARITIES DURING THE 2009 H1N1 INFLUENZA PANDEMIC

by

Andrew E. Burger, Doctor of Philosophy

Utah State University, 2018

Major Professor: Dr. Eric Reither

Department: Sociology

In 2011, the Centers for Disease Control and Prevention (CDC) published its final report on H1N1 vaccination during the 2009 pandemic. While this report provided information for those populations recommended by the CDC to receive the H1N1 vaccination, it lacked detail and did not disaggregate by important sociodemographic characteristics such as race/ethnicity or gender. Through a series of three research papers, my dissertation expands on the CDC report by paying careful attention to racial, ethnic, and gender disparities in H1N1 vaccination. My dissertation also considers the influence of sociodemographic characteristics, as well as attitudes and beliefs regarding H1N1. Paper 1 explores the diversity of the U.S. Hispanic population by estimating H1N1 vaccination uptake among U.S.-born and foreign-born Hispanics. Employing the Fundamental Cause Theory (FCT), this paper investigates how socioeconomic characteristics account for ethnic differences in vaccination uptake. In Paper 2, I shift my focus to H1N1 vaccination disparities between U.S. non-Hispanic whites and non-

Hispanic blacks. Utilizing concepts from the Health Belief Model (HBM), I estimate differences in vaccination behavior by race/ethnicity and gender while controlling for both FCT and HBM factors. In Paper 3, I provide a more detailed account of H1N1 vaccination by race/ethnicity and gender by specifying the direct and indirect influence of SES and health belief factors through a series of structural equation models (SEM). Results from this paper reinforce the importance of recognizing racial disparities in vaccination and considering the intersectionality of race and gender. My dissertation provides a comprehensive view of the societal determinants of H1N1 vaccination behavior during the 2009 pandemic in the United States for men and women from different racial and ethnic groups. Based on my research findings, I present suggestions on how to address racial/ethnic and gender disparities in H1N1 vaccination.

PUBLIC ABSTRACT

A MODERN PLAGUE: U.S. RACIAL AND ETHNIC VACCINATION DISPARITIES DURING THE 2009 H1N1 INFLUENZA PANDEMIC

By

Andrew E. Burger

On June 11, 2009 the World Health Organization announced that a novel strain of H1N1 influenza was being classified a Phase 6 pandemic, the highest level of alarm indicating that the disease was present worldwide and its spread was inevitable. While seasonal influenza epidemics occur annually, the 2009 H1N1 strain was the first novel pandemic influenza since the 1968 Hong Kong flu. The 2009 H1N1 pandemic provides a case study of how the U.S. population responded to an emergent and potentially lethal infectious disease. The richness and variety of public health data presents an opportunity to examine predictors of vaccination among men and women from different racial/ethnic groups. Because vaccination is often the most effective way to prevent influenza, it is important to understand the predictors of low vaccination uptake during the H1N1 pandemic to better prepare for future novel outbreaks of influenza.

Through a series of three research papers, my dissertation provides a comprehensive examination of the ways that race, ethnicity and gender affected H1N1 vaccination behavior. Paper 1 explores the diversity of the U.S. Hispanic population by estimating H1N1 vaccination uptake among U.S-born and foreign-born Hispanics. In Paper 2, I shift my focus to H1N1 vaccination disparities between non-Hispanic whites

and non-Hispanic blacks in the U.S. This paper further explores racial disparities in vaccination by examining intersections with gender and analyzing the influence of attitudes and beliefs about the H1N1 vaccine. In Paper 3, I provide a more detailed account of the socioeconomic and attitudinal mechanisms through which race, ethnicity and gender influence H1N1 vaccination. My research confirms large racial/ethnic disparities in H1N1 vaccination and identifies mechanisms amenable to policy change that could reduce the disease burden of a future influenza pandemic.

DEDICATION

I dedicate this dissertation to my loving and supportive parents, Richard and Annette Burger, whose infinite positive influence on my life I could never be quantify. Thank you Mom and Dad.

ACKNOWLEDGMENTS

I would like to express my gratitude and thanks to the many individuals who have helped me on the path to finishing my dissertation. Since completing my comprehensive exams, I have worked as a professional researcher for The Church of Jesus Christ of Latter-day Saints, moved twice, lived in my in-laws basement only once, and finally become a faculty member in the sociology department at BYU-Idaho. I am extremely grateful for all the valuable feedback and counseling my colleagues provided during this time. After approximately 5 years of balancing full-time employment, family, and research, I am excited to conclude this chapter of my professional life.

I am extremely grateful for the insightful input of all my committee members – often as co-authors of published (or soon to be published) articles. I am especially grateful to my committee chair and mentor Dr. Eric Reither for his incredible dedication and support to my research. While oft perceived as a relentless taskmaster, I am indebted to Eric for helping me become a more competent and capable researcher – in addition to gaining a love of mountain biking (but not necessarily the combination of mountain biking and Bluebird chicken). Thank you Eric for your support and excellent mentoring.

In the end though, I would not be here without the heroic support of my amazing wife Nicole. With undaunted courage, Nicole has stood with me through the hills and valleys of my graduate career. Always there to encourage and support, I am eternally grateful for Nicole and her love and companionship. Not only did she support me through writing a dissertation, but did so while raising four beautiful children (Emma, Abigail,

Adam, and Daniel) – an accomplishment of greater comparable worth than any dissertation I could produce.

CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

INTRODUCTION

On June 11, 2009 the World Health Organization announced that a novel strain of H1N1 influenza was being classified a Phase 6 pandemic, the highest level of alarm indicating that the disease was present worldwide and its spread was inevitable (Chan 2009). While seasonal influenza epidemics occur annually, the 2009 H1N1 strain was the first novel pandemic influenza since the 1968 Hong Kong flu (Potter 2001). Like other pandemics, the 2009 H1N1 strain was particularly contagious and infected an estimated 1 in 5 adults and 46% of all children worldwide (Van Kerkhove et al. 2013). This high level of contagion is because pandemic influenzas are new viruses for which there is little previously established immunity within the population. Although it spread quickly across the globe, the 2009 H1N1 virus fortunately was not as lethal as past pandemics such as the 1918 flu pandemic which produced a mortality burden in excess of 50 million worldwide (Johnson and Mueller 2002; Murray et al. 2007). Estimates of mortality directly attributable to 2009 H1N1 place total deaths, globally, at around 284,500 (Dawood et al. 2012; Simonsen et al. 2013).

In the United States, Viboud et al. (2010) estimate that 44,100 deaths were attributable to H1N1, which is similar to a typical seasonal influenza epidemic. However, like other pandemic influenzas, the risk of death and health complications was higher among the young and healthy (Jain et al. 2009; Louie et al. 2009; Miller et al. 2010; Shrestha et al. 2011; Truelove et al. 2011). For instance, Lemaitre and Carrat (2010) found that young adults in France and the U.S. experienced uncharacteristically high rates of mortality during the H1N1 pandemic.

The Public Health Response to H1N1

Given the pandemic nature of the H1N1 virus and its ability to spread quickly, creation of a vaccine to prevent the disease became a global public health priority (WHO 2009). The Centers for Disease Control and Prevention (CDC) in May of 2009 announced a $1 billion commitment to the development of an H1N1 vaccine (CDC 2009b). In addition to funding vaccine development – crucial in the successful prevention of disease – additional funds were allotted to address the 2009 H1N1 pandemic. Overall, the U.S. federal government allocated more than $6 billion in response to the 2009 H1N1 pandemic, with the majority of the money spent on vaccine development/distribution and additional funding provided for public health awareness programs (GAO 2011). Despite heightened attention the pandemic received via various media outlets (Rambhia et al. 2010) and the subsidization of the cost of the vaccine by the federal government, reports show overall low vaccination rates in the U.S. (CDC 2009c; Rambhia et al. 2010; SteelFisher et al. 2010).

CDC Final estimates of H1N1 Vaccination

In 2011, the CDC produced their final estimates of H1N1 vaccination during the 2009 pandemic (CDC 2011). This report, which used data from both the 2009 Behavioral Risk Factor Surveillance System (BRFSS) and the 2009 National H1N1 Flu Survey (NHFS), provides estimates of 2009 H1N1 vaccination in the general U.S. population and among certain subpopulations considered to be at particular risk of complications due to the H1N1 virus. The CDC issued special H1N1 vaccination recommendations for pregnant women, persons living with infants aged < 6 months, emergency medical

personal, those aged 6 months to 24 years, and those 25-64 with medical conditions that put them at risk of severe flu complications (CDC 2009a). Below in Table 1 is a reproduction of the CDC's final 2009 H1N1 vaccination estimates.

TABLE 1. Estimated influenza A (H1N1) 2009 monovalent vaccination coverage* among children and adults, by selected age and priority subgroups — United States†, Behavioral Risk Factor Surveillance System (BRFSS) and National 2009 H1N1 Flu Survey (NHFS), October 2009 through May 2010

	2009 H1N1 Flu Vaccine		2009 Seasonal Flu Vaccine	
Received H1N1 Vaccine?	%Yes	%No	%Yes	%No
Persons aged ≥6 mos	27.0	73.0	41.2	58.8
Children, 6 mos to 17 yrs	40.2	59.8	43.7	56.3
Persons ≥18 yrs	22.7	77.3	40.4	59.6
Persons in initial target groups**	34.2	65.8	-	-
Persons 25–64 yrs, at high risk††	28.6	71.4	-	-
Persons 25–64 yrs, not in initial target groups	16.7	83.3	-	-
Persons aged ≥65 yrs	28.8	71.2	69.6	19.5

*Coverage estimates are for persons with reported vaccination during October 2009—May 2010 who were interviewed during November 2009—June 2010.
† Excludes U.S. territories
** Pregnant women, persons who live with or provide care for infants aged <6 months, health–care and emergency medical services personnel, children and young adults aged 6 months—24 years, and persons aged 25—64 years who have medical conditions that put them at higher risk for influenza–related complication
†† High risk includes asthma, other lung problems, diabetes, heart disease, kidney problems, anemia, weakened immune system caused by a chronic illness or by medicines taken for a chronic illness.

Note. Table adapted from "Centers for Disease Control and Prevention. 2011. "Final estimates for 2009–10 Seasonal Influenza and Influenza A (H1N1) 2009 Monovalent Vaccination Coverage – United States, August 2009 through May, 2010." http://www.cdc.gov/flu/fluvaxview/coverage_0910estimates.htm.
Public Domain

Table 1 shows that H1N1 vaccination rates were low compared to seasonal influenza in various subpopulations, including groups urged by the CDC to receive the 2009 H1N1 vaccine due to health complication risks. The Government Accountability Office (GAO), in reporting how government funds were spent and their overall impact during the 2009 H1N1 pandemic, notes that the "creditability of all levels of government was diminished when the amount of vaccine available to the public in October 2009 did not meet the expectations set by federal officials" (GAO 2011:27). The initial lack of vaccine availability, the shift in the public's confidence in the government's ability to handle the pandemic, and changing opinions regarding the efficacy and safety of the 2009 H1N1 vaccine all likely played a role in low H1N1 vaccination rates (CDC 2011; Ofri 2009).

While the 2011 CDC report provides broad estimates of H1N1 vaccination rates, it does not disaggregate these rates by race/ethnicity, sex, or other important sociodemographic characteristics. Previous research has identified disparities in *seasonal* influenza vaccination uptake by race/ethnicity and gender—as well as education, income, health insurance availability and perceptions about the safety and effectiveness of vaccination (Burger et al. 2011; Dee et al. 2011; Haviland et al. 2011; Mamelund 2011; Setse et al. 2011; Vlahov et al. 2012; Wong and Sam 2010). While a few studies have examined such disparities in 2009 H1N1 vaccination rates (Dee et al. 2011; Frew et al. 2011; Plough et al. 2011; Quinn et al. 2011; Uscher-Pines, Maurer and Harris 2011), sample sizes are sometimes limited in these otherwise exceptional studies, precluding an in-depth evaluation of vaccination disparities by race/ethnicity or gender.

The purpose of my dissertation is to estimate the magnitude of racial/ethnic and gender disparities in H1N1 vaccination and to understand their sociodemographic and attitudinal underpinnings. Following a multi-paper format, my dissertation contains three distinct yet thematically related research articles investigating predictors of 2009 H1N1 vaccination. The results of my dissertation provide strong evidence of racial/ethnic and gender disparities in H1N1 vaccination uptake and justify, I believe, the consideration of sociodemographic characteristics – in addition to biological risk factors – in the emergency preparedness plans of the U.S. government in the face of a future influenza pandemic.

OUTLINE OF DISSERTATION

Paper 1: The Influence of Hispanic Ethnicity and Nativity Status on 2009 H1N1 Pandemic Vaccination Uptake in the United States

Articles published shortly after the 2009 H1N1 pandemic suggested that the 2009 H1N1 influenza virus disproportionately affected Hispanics (Miller et al. 2010; Slopen et al. 2009). Because vaccination for H1N1 influenza is the most effective way of preventing the disease (CDC 2009a), it is troubling to see evidence that racial and ethnic minorities, including Hispanics, reported low levels of 2009 H1N1 vaccination (Frew et al. 2011; Plough et al. 2011; Quinn et al. 2011; Uscher-Pines, Maurer and Harris 2011). These lower rates of vaccination uptake likely contributed to a relatively high burden of H1N1-related morbidity among racial/ethnic minorities (Dee et al. 2011).

Treating all individuals who identify as Latina/o or Hispanic as a single homogenous group could misrepresent this quickly growing ethnic population (Lopez, Gonzalez-Barrera and Cuddington 2013). Differences within the ethnic label "Hispanic" exist by immigration status (Kochhar 2014), country of origin (Pabon-Nau et al. 2010), generation since-migration (Dustmann, Frattini and Lanzara 2012), and language (Wisnivesky et al. 2012). This paper will explore differences among Hispanics by incorporating nativity-status—i.e., whether the individual is US-born or foreign-born—into the analysis.

To understand how socioeconomic status influences vaccination uptake, I utilize concepts associated with the Fundamental Cause Theory (FCT). Developed in response to individualized "blame-the-victim" explanations of health during the 1990s, FCT emphasizes the role of societal inequalities in health outcomes (Link and Phelan 1995). FCT argues that public health initiatives targeted at the proximate causes of disease are not particularly effective at addressing population health disparities because they lack the ability to change the underlying "fundamental" causes, such as poverty (Phelan and Link 2005). Although influenza vaccination promotion campaigns such as those seen during the 2009 H1N1 pandemic are beneficial (Ma et al. 2006), they cannot, according to FCT, overcome deeply rooted societal inequalities which influence health and health behaviors. In the case of the H1N1 pandemic, FCT postulates that socioeconomically disadvantaged individuals would be less likely to vaccinate.

Even when health resources are readily available, individuals must be able to access "resources that can be used to avoid risks or to minimize the consequences of

disease once it occurs" (Link and Phelan 1995:87). Through the use of *flexible resources*, which Link and Phelan (1995) describe as "money, knowledge, power, prestige, and the kinds of interpersonal resources embodied in the concepts of social support and social network", advantaged individuals achieve better health outcomes (81). Disparities in flexible resources therefore produce health disparities, such as H1N1 vaccination disparities. While limited to the data available, examples of flexible resources I include in my analysis include income, education, and marital status. Another crucial resource, healthcare coverage, is also included in every paper as a factor that could negate insufficient flexible resources by increasing individuals' direct access to vaccines and medical assistance. Addressing deep societal inequalities in income and education are important in improving health in society, especially among minorities (Kayman and Ablorh-Odjidja 2006; Usher-Pines et al. 2007). Even in the midst of persistent social inequality, improving healthcare coverage may improve vaccination rates and reduce the disease burden among racial/ethnic minorities during a future pandemic.

The first aim of this paper is to identify levels of 2009 H1N1 vaccination uptake among US-born and foreign-born Hispanics. A second important aim is to identify socioeconomic factors that may explain low 2009 H1N1 vaccination among US-born and foreign-born Hispanics when compared to non-Hispanic whites. Previous work, guided by Fundamental Cause Theory (FCT), has identified broad socioeconomic inequalities as key determinants of high disease burden and low preventative healthcare utilization among racial/ethnic minorities (Phelan and Link 2005). By including measures of flexible resources such as healthcare coverage, education, and other socioeconomic resources, I

will identify the extent to which these predictors are associated with ethnic disparities in H1N1 vaccination during the 2009 pandemic.

Paper 2: The Impact of Gender and Racial Identification on H1N1 Vaccination Beliefs and Behaviors in the United States

Utilizing the National H1N1 Flu Survey (NHFS), this paper continues to explore how SES may account for disparities in H1N1 vaccination among white and black adults in the U.S. It also introduces (1) the paradigm of intersectionality by combining measures of race and sex, and (2) a theoretical explanation of H1N1 vaccination behavior adapted from the Health Belief Model (HBM).

Originally developed by a group of social psychologists employed by the U.S. Public Health Service, the Health Belief Model (HBM) presents a theoretical framework where health behavior is the result of both external stimuli and cognitive action (Strecher, Champion and Rosenstock 1997). The HBM relies on four main concepts in predicting health behavior: *perceived susceptibility, perceived severity, perceived benefits, and perceived barriers*. These concepts have proven especially useful in the analysis of health behaviors such as flu vaccinations.

This paper endeavors to understand how certain sociodemographic characteristics, such as educational attainment and health insurance, attenuate or explain racial disparities in vaccination between non-Hispanic whites and non-Hispanic blacks. In addition to providing basic descriptive information on H1N1 vaccination among non-Hispanic blacks, I show how H1N1 vaccination uptake varies by race and gender across socioeconomic characteristics and HBM components. This could provide valuable

information on how to better target influenza vaccination campaigns for non-Hispanic blacks in the future.

Paper 3: Impact of Race/Ethnicity and Gender on 2009 H1N1 Vaccination in the United States: A Structural Equation Modeling Approach

The purpose of this study is to identify racial/ethnic and gender effects in predicting H1N1 vaccination uptake. Utilizing both the Health Belief Model (HBM) and Fundamental Cause Theory (FCT), I present a structural equation model (SEM) estimating the effects of race/ethnicity and gender when considering potential mediators on the pathway to vaccination. Using data available from the 2009 National H1N1 Flu Survey (NHFS), I estimate the extent to which variables derived from HBM and FCT mediate vaccination disparities among non-Hispanic white, non-Hispanic black, and Hispanic men and women. This paper seeks to understand how SES, H1N1 beliefs, and healthcare may act as mediators in the relationship between race/ethnicity, gender and vaccination. Accounting for these mediators, I expect odds of vaccination to vary among racial/ethnic and gender groups. This analysis goes beyond what I have previously accomplished in my dissertation by specifying exactly the hypothesized relationship of race/ethnicity and gender on H1N1 vaccination.

CONCLUSION

My dissertation provides detailed estimates of H1N1 vaccination uptake by race, ethnicity, gender, and nativity status, complementing information previously compiled by the CDC. As shown in the results of my dissertation, significant racial/ethnic differences

existed during the 2009 H1N1 pandemic. These racial/ethnic differences however vary substantially after considering factors such as gender, nativity status, socioeconomic status, and psychosocial characteristics. In addition, my dissertation synthesizes two important theories of health behavior (FCT and HBM) in understanding vaccination disparities. This comprehensive review of H1N1 vaccination behavior in the United States can provide useful guidance in the creation of health promotion campaigns designed to increase vaccination participation. Such action could be crucial in the reduction of the potential disease burden attributable to a future influenza pandemic.

REFERENCES

Burger, Andrew. E., Eric. Reither, David. W. Ramos, and Sun. Y. Jeon. 2011. "Racial and Ethnic Disparities in Seasonal Influenza Vaccination among Utah Adults." *Utah's Health: An Annual Review* 16:10-20.

Centers for Disease Control and Prevention. 2009a. "2009 H1N1 Vaccination Recommendations." (https://www.cdc.gov/h1n1flu/vaccination/acip.htm).

Centers for Disease Control and Prevention. 2009b. "CDC Telebriefing on Investigation of Human Cases of H1N1 Flu, May 26, 2009." (https://www.cdc.gov/media/pressrel/2009/a090526.htm).

Centers for Disease Control and Prevention. 2009c. "Questions and Answers on 2009 H1N1 Vaccine Financing." (https://www.cdc.gov/H1N1flu/vaccination/statelocal/vaccine_financing.htm).

Centers for Disease Control and Prevention. 2009d. "Patients hospitalized with 2009 pandemic influenza A (H1N1)-New York City, May 2009." *Morbidity and Mortality Weekly Report* 58(51/52):1436-40.

Centers for Disease Control and Prevention. 2011. "Final Estimates for 2009–10 Seasonal Influenza and Influenza A (H1N1) 2009 Monovalent Vaccination Coverage – United States, August 2009 through May, 2010." (https://www.cdc.gov/flu/fluvaxview/coverage_0910estimates.htm).

Chan, Margaret. 2009. "Statement to the Press by WHO Director-General Dr. Margaret Chan: World Now at Start of 2009 Influenza Pandemic." World Health Organization.

(http://www.who.int/mediacentre/news/statements/2009/h1n1_pandemic_phase6_20090611/en/).

Dawood, Fatimah S, A Danielle Iuliano, Carrie Reed, Martin I Meltzer, David K Shay, Po-Yung Cheng, Don Bandaranayake, Robert F Breiman, W Abdullah Brooks, and Philippe Buchy. 2012. "Estimated Global Mortality Associated with the First 12 Months of 2009 Pandemic Influenza A H1N1 Virus Circulation: a Modelling Study." *The Lancet Infectious Diseases* 12(9):687-95.

Dee, Deborah L, Diana M Bensyl, Jacqueline Gindler, Benedict I Truman, Barbara G Allen, Tiffany D'Mello, Alejandro Pérez, Laurie Kamimoto, Matthew Biggerstaff, and Lenee Blanton. 2011. "Racial and Ethnic Disparities in Hospitalizations and Deaths Associated with 2009 Pandemic Influenza A (H1N1) Virus Infections in the United States." *Annals of Epidemiology* 21(8):623-30.

Dustmann, Christian, Tommaso Frattini, and Gianandrea Lanzara. 2012. "Educational Achievement of Second-Generation Immigrants: an International Comparison." *Economic Policy* 27(69):143-85.

Frew, Paula M, Brooke Hixson, Carlos del Rio, Alejandra Esteves-Jaramillo, and Saad B Omer. 2011. "Acceptance of Pandemic 2009 Influenza A (H1N1) Vaccine in a Minority Population: Determinants and Potential Points of Intervention." *Pediatrics* 127(Supplement 1):S113-S19.

Government Accountability Office. 2011. "Influenza Pandemic: Lessons from the H1N1 Pandemic Should be Incorporated into Future Planning." (https://www.gao.gov/products/GAO-11-632).

Haviland, Amelia M, Marc N Elliott, Katrin Hambarsoomian, and Nicole Lurie. 2011. "Immunization Disparities by Hispanic Ethnicity and Language Preference." *Archives of Internal Medicine* 171(2):158-65.

Jain, Seema, Laurie Kamimoto, Anna M. Bramley, Ann M. Schmitz, Stephen R. Benoit, Janice Louie, David E. Sugerman, Jean K. Druckenmiller, Kathleen A. Ritger, Rashmi Chugh, Supriya Jasuja, and Meredith Deutscher. 2009. "Hospitalized Patients with 2009 H1N1 Influenza in the United States, April-June 2009." *New England Journal of Medicine* 361(20):1935-44.

Johnson, Niall P. and Juergen Mueller. 2002. "Updating the Accounts: Global Mortality of the 1918-1920 "Spanish" influenza pandemic." *Bulletin of the History of Medicine* 76(1):105-15.

Kochhar, Rakesh. 2014. *Latino Jobs Growth Driven by U.S. Born: Immigrants No Longer the Majority of Hispanic Workers*. Washington, D.C.: Pew Research Center's Hispanic Trends Project. (http://www.pewhispanic.org/2014/06/19/latino-jobs-growth-driven-by-u-s-born/)

Kayman, Harvey, and Angela Ablorh-Odjidja. 2006. "Revisiting Public Health Preparedness: Incorporating Social Justice Principles into Pandemic Preparedness Planning for Influenza." *Journal of Public Health Management and Practice* 12(4):373-80.

Lemaitre, Magali, and Fabrice Carrat. 2010. "Comparative Age Distribution of Influenza Morbidity and Mortality During Seasonal Influenza Epidemics and the 2009 H1N1 Pandemic." *BMC Infectious Diseases* 10(1):162.

Link, Bruce G., and Jo Phelan. 1995. "Social conditions as fundamental causes of disease." *Journal of Health and Social Behavior* (Extra Issue):80-94.

Lopez, Mark Hugo, Ana Gonzalez-Barrera, and Danielle Cuddington. 2013. "Diverse Origins: The nation's 14 largest Hispanic-Origin Groups." Washington, D.C.: Pew Hispanic Center. (http://www. pewhispanic. org/2013/06/19/diverse-origins-the-nations-14-largest-hispanic-origin-groups).

Louie, Janice K., Meileen Acosta, Kathleen Winter, Cynthia Jean, Shilpa Gavali, Robert Schechter, Duc Vugia, Kathleen Harriman, Bela Matyas, Carol A. Glaser, Michael C. Samuel, Jon Rosenberg, John Talarico, and Douglas Hatch. 2009. "Factors Associated with Death or Hospitalization Due to Pandemic 2009 Influenza A(H1N1) Infection in California." *JAMA* 302(17):1896-902.

Ma, K.K., W. Schaffner, C. Colmenares, J. Howser, J. Jones, and K.A. Poehling. 2006. "Influenza Vaccinations of Young Children Increased with Media Coverage in 2003." *Pediatrics* 117(2):e157.

Mamelund, Svenn-Erik. 2011. "Geography May Explain Adult Mortality from the 1918–20 Influenza Pandemic." *Epidemics* 3(1):46-60.

Miller, Russell R., Boaz A. Markewitz, Robert T. Rolfs, Samuel M. Brown, Kristin K. Dascomb, Colin K. Grissom, Michael D. Friedrichs, Jeanmarie Mayer, Eliotte L. Hirshberg, and Jamie Conklin. 2010. "Clinical Findings and Demographic Factors Associated with ICU Admission in Utah due to Novel 2009 Influenza A (H1N1) infection." *CHEST Journal* 137(4):752-58.

Murray, Christopher J.L., Alan D. Lopez, Brian Chin, Dennis Feehan, and Kenneth H. Hill. 2007. "Estimation of Potential Global Pandemic Influenza Mortality on the Basis of Vital Registry Data from the 1918-20 Pandemic: a Quantitative Analysis." *The Lancet* 368(9554):2211-18.

Ofri, Danielle. 2009. "The Emotional Epidemiology of H1N1 Influenza Vaccination." *New England Journal of Medicine* 361(27):2594-95.

Pabon-Nau, Lina P., Amy Cohen, James B. Meigs, and Richard W. Grant. 2010. "Hypertension and Diabetes Prevalence among U.S. Hispanics by Country of Origin: the National Health Interview Survey 2000-2005." *Journal of General Internal Medicine* 25(8):847-52.

Phelan, Jo C., and Bruce G. Link. 2005. "Controlling Disease and Creating disparities: a Fundamental Cause Perspective." *The Journals of Gerontology* Series B:60(Special Issue 2):S27.

Plough, Alonzo, Benjamin Bristow, Jonathan Fielding, Stephanie Caldwell, and Sinan Khan. 2011. "Pandemics and Health Equity: Lessons Learned from the H1N1 Response in Los Angeles County." *Journal of Public Health Management and Practice* 17(1):20.

Potter, Christopher W. 2001. "A History of Influenza." *Journal of Applied Microbiology* 91(4):572-79.

Quinn, Sandra Crouse, Supriya Kumar, Vicki S Freimuth, Donald Musa, Nestor Casteneda-Angarita, and Kelley Kidwell. 2011. "Racial Disparities in Exposure,

Susceptibility, and Access to Health Care in the U.S. H1N1 Influenza Pandemic." *American Journal of Public Health* 101(2):285.

Rambhia, Kunal J, Matthew Watson, Tara Kirk Sell, Richard Waldhorn, and Eric Toner. 2010. "Mass Vaccination for the 2009 H1N1 Pandemic: Approaches, Challenges, and Recommendations." *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science* 8(4):321-30.

Setse, Rosanna W., Gary L. Euler, Amparo G. Gonzalez-Feliciano, Leah N. Bryan, Carolyn Furlow, Cindy M. Weinbaum, and James A. Singleton. 2011. "Influenza Vaccination Coverage—United States, 2000–2010." *Morbidity and Mortality Weekly Report (MMWR).* Supplements:60(01):38-41.

Shrestha, Sundar S., David L. Swerdlow, Rebekah H. Borse, Vimalanand S. Prabhu, Lyn Finelli, Charisma Y. Atkins, Kwame Owusu-Edusei, Beth Bell, Paul S. Mead, Matthew Biggerstaff, Lynnette Brammer, Heidi Davidson, Daniel Jernigan, Michael A. Jhung, Laurie A. Kamimoto, Toby L. Merlin, Mackenzie Nowell, Stephen C. Redd, Carrie Reed, Anne Schuchat and Martin I. Meltzer. 2011. "Estimating the Burden of 2009 Pandemic Influenza A (H1N1) in the United States (April 2009–April 2010)." *Clinical Infectious Diseases* 52(suppl 1):S75.

Simonsen, Lone, Peter Spreeuwenberg, Roger Lustig, Robert J. Taylor, Douglas M. Fleming, Madelon Kroneman, Maria D. Van Kerkhove, Anthony W. Mounts, and W. John Paget. 2013. "Global Mortality Estimates for the 2009 Influenza Pandemic from the GLaMOR Project: a Modeling Study." *PLoS Med* 10(11):e1001558.

SteelFisher, Gillian K., Robert J. Blendon, Mark M. Bekheit, and Keri Lubell. 2010. "The Public's Response to the 2009 H1N1 Influenza Pandemic." *New England Journal of Medicine* 362(22):e65.

Strecher, Victor J., Victoria L. Champion, and Irwin M. Rosenstock. 1997. "The Health Belief Model and Health Behavior." Pp. 71-91 in *Handbook of Health Behavior Research*, edited by David S. Gochman. New York, NY: Plenum Press.

Truelove, Shaun A., Amit S. Chitnis, Richard T. Heffernan, Amy E. Karon, Thomas E. Haupt, and Jeffrey P. Davis. 2011. "Comparison of Patients Hospitalized with Pandemic 2009 Influenza A(H1N1) Virus Infection during the First Two Pandemic Waves in Wisconsin." *Journal of Infectious Diseases* 203(6):828-37.

Uscher-Pines, Lori, Patrick S. Duggan, Joshua P. Garron, Ruth A. Karron, and Ruth R. Faden. 2007. "Planning for an Influenza Pandemic: Social Justice and Disadvantaged Groups." *Hastings Center Report*: 32-39.

Uscher-Pines, Lori, Jurgen Maurer, and Katherine Harris. 2011. "Racial and Ethnic Disparities in Uptake and Location of Vaccination for 2009-H1N1 and Seasonal Influenza." *American Journal of Public Health*. 101(7):1252-1255.

Van Kerkhove, Maria D., Siddhivinayak Hirve, Artemis Koukounari, Anthony W. Mounts, and H1N1pdm Serology Working Group. 2013. "Estimating Age-Specific Cumulative Incidence for the 2009 Influenza Pandemic: a Meta-Analysis of A(H1N1)pdm09 Serological Studies from 19 Countries." *Influenza and Other Respiratory Viruses* 7(5):872-886.

Viboud, Cecile, Mark Miller, Donald R. Olson, Michael Osterholm, and Lone Simonsen. 2010. "Preliminary Estimates of Mortality and Years of Life Lost Associated with the 2009 A/H1N1 Pandemic in the US and Comparison with Past Influenza Seasons." *PLoS currents* 2.

Vlahov, David, Keosha T. Bond, Kandice C. Jones, and Danielle C. Ompad. 2012. "Factors Associated with Differential Uptake of Seasonal Influenza Immunizations among Underserved Communities during the 2009–2010 Influenza Season." *Journal of Community Health* 37(2):282-87.

Wisnivesky, Juan P., Katherine Krauskopf, Michael S. Wolf, Elizabeth A.H. Wilson, Anastasia Sofianou, Melissa Martynenko, Ethan A. Halm, Howard Leventhal, and Alex D. Federman. 2012. "The Association between Language Proficiency and Outcomes of Elderly Patients with Asthma." *Annals of Allergy, Asthma & Immunology* 109(3):179-84.

Wong, Li Ping and I-Ching Sam. 2010. "Factors Influencing the Uptake of 2009 H1N1 Influenza Vaccine in a Multiethnic Asian population." *Vaccine* (28):4499-505.

World Health Organization. 2009. "WHO Recommendations on Pandemics (H1N1) 2009 Vaccines." (http://www.who.int/csr/disease/swineflu/notes/h1n1_vaccine_20090713/en/).

PAPER 1

THE INFLUENCE OF HISPANIC ETHNICITY AND NATIVITY STATUS ON 2009 H1N1 PANDEMIC VACCINATION UPTAKE IN THE UNITED STATES

BY BURGER, ANDREW E., ERIC N. REITHER, ERIN TROUTH HOFMANN, AND SVENN-ERIK MAMELUND.

Published

In the

Journal of Immigrant and Minority Health (2018) 20:561-568

ABSTRACT

Background: Previous research suggests Hispanic vaccination rates for H1N1 were similar to non-Hispanic whites. These previous estimates do not take into account nativity status.

Methods: Using data from the 2010 National Health Interview Survey, we estimate adult H1N1 vaccination rates for non-Hispanic whites (n=8,780), U.S.-born Hispanics (n=1,142), and foreign-born Hispanics (n=1,912). Using logistic regression models, we estimate H1N1 vaccination odds by ethnicity and nativity status.

Results: Foreign-born Hispanics experienced the lowest rates of H1N1 vaccination (15%), followed by U.S.-born Hispanics (18%) and non-Hispanic whites (21%). Regression models show that the odds of H1N1 vaccination did not differ among these three groups after controlling for sociodemographic characteristics.

Discussion: Insufficient resources and lower-rates of healthcare coverage among Hispanics were partly responsible for the lower rates of H1N1 vaccination in comparison to non-Hispanic whites. Addressing disparities in important resources among Hispanics could improve future influenza vaccination uptake, reducing rates of morbidity and mortality.

BACKGROUND

In 2009, the United States experienced its first pandemic influenza since the 1968 Hong Kong Flu (Tognotti 2009). With more than 60 million cases, 274,304 hospitalizations, and 12,469 deaths, 2009 H1N1 influenza created a substantial disease burden in the United States (Shrestha et al. 2011). While evidence suggests that certain older populations had developed partial immunity to the 2009 H1N1 influenza virus (Mamelund 2011), the majority of Americans were at risk of infection, particularly the young (2009). Because populations generally lack sufficient immunity to pandemic influenzas, vaccines are key to preventing infection—but only if they are produced and delivered efficiently (Nichol and Treanor 2006). Whereas 40% of U.S. adults received the 2009-2010 vaccine for seasonal influenza, only 23% of U.S. adults received the separately administered 2009 H1N1 vaccine (2011).

While this low overall rate of H1N1 vaccination is troubling, it is also concerning that Hispanics were at higher risk of H1N1 exposure (Blumenshine et al. 2008; Quinn et al. 2011) and more likely to experience H1N1-related complications such as hospitalization and mortality than non-Hispanic whites (Dee et al. 2011; Kwan-Gett, Baer and Duchin 2009; Miller et al. 2010; Navaranjan et al. 2014; Ritger et al. 2009; Thompson et al. 2011; Truelove et al. 2011). Although previous research suggests that Hispanics were at greater risk of H1N1 exposure and health complications, Uscher-Pines, Maurer and Harris (2011) found no difference between Hispanics and non-Hispanic whites with respect to 2009 H1N1 vaccination rates. However, due to limitations in the sampling design and the exclusion of key indicators, this otherwise excellent study was

unable to examine vaccination uptake among Hispanics by nativity status. We believe that assessing H1N1 vaccination uptake among U.S.-born and foreign-born Hispanics will provide a more accurate and complete portrayal of Hispanic vaccination behavior during the 2009 flu pandemic.

The Diversity of Hispanics

Hispanics are frequently grouped into a single ethnic category in health surveys. Unfortunately, this practice conceals diversity within this fast-growing ethnic group (Umaña-Taylor and Fine 2001), especially between foreign-born and U.S.-born Hispanics. Previous research identifies significant differences between U.S.-born and foreign-born Hispanics across multiple health outcomes, including birth weight (Acevedo-Garcia, Soobader and Berkman 2007), diabetes and hypertension (Pabon-Nau et al. 2010), and vaccinations (Lu et al. 2014). We believe that differentiating foreign-born Hispanics from U.S.-born Hispanics is warranted, given significant differences in health as well as education, income and other sociodemographic characteristics (Kohler and Lazarín 2007; Suro and Passel 2003). We additionally recognize diversity among foreign-born Hispanics with respect to acculturation and social capital, including factors such as English language use, the length of residence in the U.S., region of birth, and citizenship status.

Disparities in "Flexible Resources"

Guiding our investigation into the determinants of relatively low vaccination uptake among Hispanics is the Fundamental Cause Theory (FCT). FCT posits that deeply

rooted societal inequalities are “fundamental causes” of disease, as those with more resources have multiple channels to seek and secure health promoting services and procedures (Link and Phelan 1995). For example, all segments of the population may not utilize even inexpensive and widely available healthcare services such as the 2009 H1N1 vaccine, since those with superior flexible resources (e.g., educational and social capital) are better positioned to adopt such protective strategies (such as vaccination) in limiting the impact of disease (Phelan and Link 2005).

With important sociodemographic and cultural differences between U.S.-born and foreign-born Hispanics, we expect that disparities in flexible resources will be influential in predicting H1N1 vaccination uptake. If disparities in flexible resources account for differences in vaccination behavior, addressing those disparities should increase the proportion of the population that is vaccinated. We expect that foreign-born Hispanics will experience the greatest improvement in the odds of vaccination when accounting for flexible resources, as they are most likely to experience high levels of disadvantage among the groups in our study.

METHODS

Data

For our analysis we use the 2010 National Health Interview Survey (NHIS). Representative of the non-institutionalized U.S. adult population, the NHIS is advantageous for our study as it also oversamples Hispanics and includes information on

H1N1 vaccination, nativity status, healthcare coverage and important sociodemographic characteristics.

Measures

Dependent variable. From January 2010 through July 2010, the NHIS asked survey participants if they had received the separately administered H1N1 pandemic vaccination at any time since October 2009. Among NHIS participants who were vaccinated for H1N1, most (76%) received the vaccine during the fall of 2009. Therefore, using the 2010 NHIS (which began collecting data in January 2010) limits the risk of false negatives, where respondents not vaccinated at the time of the survey received the vaccine at a future date (Burger and Reither 2014).

Independent variables. The independent variables of primary interest are ethnicity and nativity status, which are self-reported by the respondent. We limit our analysis to U.S.-born non-Hispanic whites, U.S.-born Hispanics and foreign-born Hispanics whose H1N1 vaccination status is known. In addition to common demographic variables (age, sex and marital status), we include two important flexible resources as described by FCT, namely education and household income. As an added measure of economic standing, we include homeownership status, which may be a better indicator of wealth than household income (Keene, Lynch and Baker 2014). The NHIS additionally provides a binary healthcare coverage variable, grouping those who have at least some coverage and those with no coverage.

To account for the possibility that vaccination uptake varied by ethnicity because of differing proportions at risk for H1N1 complications, we create a binary "pre-existing

condition" variable that includes individuals who reported one or more of the following conditions: pregnancy, asthma, diabetes, heart disease, or weak/failing kidneys.

The NHIS enables us to make additional distinctions among foreign-born Hispanics through self-reported measures of citizenship status, duration in the U.S., and the respondent's region of birth (dichotomized into Central America/South America). As a measure of English language ability, we include the NHIS field technicians' report of the language in which the respondent was interviewed, which we group into two categories, those who responded in English (including mixed English and Spanish) and those who responded in Spanish only.

Analyses

We estimate H1N1 vaccination uptake percentages for U.S.-born non-Hispanic whites, U.S.-born Hispanics, and foreign-born Hispanics. Also, we provide descriptive information on various sociodemographic characteristics, including measures of flexible resources. We then estimate a series of nested, binary logistic regression models to find the odds of H1N1 vaccination among all three ethnic groups, both before and after accounting for various flexible resources. As we examine H1N1 uptake specifically among foreign-born Hispanics, we also present descriptive characteristics unique to these immigrants. Afterwards, we estimate a stratified logistic regression model to determine how the odds of vaccination vary among foreign-born Hispanics by characteristics such as duration of residence in the U.S. and English language usage.

We perform all analyses using STATA 13 (StataCorp 2017), taking into account the complex sampling design of the NHIS and following CDC guidelines for variance

estimation (CDC 2015). The study was approved by the Utah State University Institutional Review Board (IRB).

RESULTS

Characteristics Associated with H1N1 Vaccination

As shown in Table 1, U.S.-born non-Hispanic whites report the highest level of H1N1 vaccination (20.7%) among all groups, which is statistically greater than either U.S.-born Hispanics or foreign-born Hispanics ($p<0.05$, one-tailed). While the difference in H1N1 vaccination between U.S.-born Hispanics and foreign-born Hispanics is modest (17.9% vs. 15.3%), it too is statistically significant ($p<0.05$, one-tailed).

Our estimates show significant sociodemographic differences among the three ethnic groups of interest. Foreign-born Hispanics are older and more likely to be male than U.S.-born Hispanics, and they are less likely to have a high school degree or equivalent certification. U.S.-born Hispanics report education levels more similar to U.S.-born whites than foreign-born Hispanics. For example, while 62.8% of non-Hispanic whites reported “some college” or more, 50.1% of U.S.-born Hispanics and only 27.9% of foreign-born Hispanics reported similar levels of education. Also, household income among U.S.-born Hispanics is similar to non-Hispanic whites except in the highest income range. In contrast, foreign-born Hispanics have significantly lower levels of household income, with more than a quarter (25.8%) of foreign-born Hispanic households earning less than $20,000. Another indicator of economic wealth, household

ownership, is significantly higher among non-Hispanic whites (75.8%) than either U.S.-born Hispanics (58.0%) or foreign-born Hispanics (45.4%).

TABLE 1. Descriptive Statistics for H1N1 Vaccination and Sociodemographic Characteristics of Respondents in the 2010 National Health Interview Survey

Characteristics	White Non-Hispanic (n=8,780)		Hispanic, U.S.-born (n=1,142)		Hispanic, Foreign-born (n=1,912)	
	%	95% CI	%	95% CI	%	95% CI
H1N1 Vaccination						
Yes	20.7	(19.8-21.6)	17.9	(15.4-20.7)	15.3	(13.4-17.5)
No	79.3	(78.4-80.2)	82.1	(79.3-84.6)	84.7	(82.5-86.6)
Sex						
Male	48.8	(47.5-50.1)	48.5	(45.0-52.1)	54.1	(51.6-56.7)
Female	51.2	(49.9-52.5)	51.5	(47.9-55.0)	45.9	(43.3-48.4)
Age						
18-34	27.3	(26.0-28.6)	52.4	(48.1-56.6)	36.8	(33.8-39.9)
35-64	53.4	(52.0-54.7)	40.5	(36.5-44.7)	54.0	(51.1-56.8)
65+	19.3	(18.3-20.4)	7.1	(5.8-8.7)	9.3	(7.9-10.9)
Marital Status						
Married	57.4	(60.0-58.7)	44.2	(40.7-47.8)	61.8	(59.0-64.5)
Not married	42.6	(41.3-44.0)	55.8	(52.2-59.3)	38.2	(35.5-41.0)
Pre-existing Condition						
No	78.2	(77.0-79.3)	83.5	(80.6-86.1)	86.6	(84.7-88.4)
Yes	21.8	(20.7-23.0)	16.5	(13.9-19.4)	13.4	(11.6-15.3)
Healthcare Coverage						
No	13.3	(12.3-14.3)	24.6	(21.6-27.8)	47.0	(44.2-49.9)
Yes	86.7	(85.7-87.7)	75.4	(72.2-78.4)	53.0	(50.1-55.8)
Homeownership Status						
Rent, other	24.2	(22.7-25.8)	42.0	(38.1-46.0)	54.6	(51.2-58.1)
Own	75.8	(74.2-77.3)	58.0	(54.0-61.9)	45.4	(41.9-48.8)
Household Income						
$0-$19,999	13.9	(12.8-15.0)	16.4	(14.1-19.0)	25.8	(23.3-28.5)
$20,000-$39,999	16.4	(14.1-21.5)	22.5	(19.6-25.7)	32.7	(30.2-35.4)
$40,000-$69,999	25.8	(23.3-26.6)	27.7	(24.2-30.3)	24.0	(21.6-26.5)
$70,000+	40.6	(38.9-42.4)	34.0	(30.4-37.7)	17.5	(15.3-20.0)
Education						
Less than High School	9.8	(8.9-10.6)	17.7	(14.9-20.9)	48.1	(45.0-51.3)
High School or GED	27.5	(26.3-28.7)	32.2	(28.9-35.7)	24.0	(21.5-26.7)
Some College	32.4	(31.2-33.6)	34.5	(31.1-38.1)	17.1	(15.0-19.3)
Bachelor or more	30.4	(29.0-31.8)	15.6	(13.1-18.6)	10.8	(9.2-12.6)

Note: % and CI estimated accounting for complex sampling design of NHIS

Determinants of H1N1 Vaccination Uptake

In Table 2, we present the estimated adjusted odds ratios for H1N1 vaccination by ethnicity and nativity status, controlling for various sociodemographic characteristics. In model 1, we control for differences in age, sex, marital status and pre-existing conditions among the three major ethnic groups in our study. When controlling for these factors, U.S.-born Hispanics do not experience statistically different odds of vaccination than non-Hispanic whites. In subsequent models, odds ratios of vaccination for U.S.-born Hispanics remain relatively unchanged. In contrast to U.S.-born Hispanics, foreign-born Hispanics report 23% lower odds of vaccination ($p<.01$) than non-Hispanic whites (model 1). Model 1 also shows that people with pre-existing conditions were 73% more likely than those without such conditions to receive the H1N1 vaccination ($p<0.001$). Across all three models, we observe statistically significant differences in the odds of H1N1 vaccination by pre-existing conditions, age, sex, and marital status.

Model 2 introduces income, education and home ownership as indicators of flexible resources described by FCT. All three of these variables are significantly associated with the odds of H1N1 vaccination. For example, those with a bachelor's degree or more education were 92% more likely to vaccinate than those with less than a high school education ($p<0.001$). Although less impactful than education, income was also a significant determinant of vaccination—with people in the highest income bracket 27% more likely to vaccinate than people in the lowest ($p<0.05$). In addition, homeowners were 16% more likely to receive an H1N1 vaccination than non-homeowners ($p<0.05$). Accounting for these flexible resources led to nearly identical and

statistically indistinguishable odds of H1N1 vaccination among U.S.-born Hispanics, foreign-born Hispanics and non-Hispanic whites, eliminating the disadvantage in vaccination uptake exhibited by foreign-born Hispanics in model 1.

Model 3 introduces healthcare coverage into the analysis. Healthcare coverage is entered apart from other FCT measures to show how it might partly mediate (i.e., explain) the effects of income and education. Healthcare coverage is a very strong predictor of vaccination, as those covered by any type of healthcare were 91% more likely to receive the H1N1 vaccine than those with no coverage – even when controlling for SES ($p<0.001$). Moreover, healthcare coverage appears to partially mediate the effect of certain flexible resources, most notably education. It is surprising that controlling for flexible resources and healthcare coverage causes the odds of vaccination to be *greater* for foreign-born Hispanics than non-Hispanic whites, a finding that approaches traditional criteria for statistical significance.

TABLE 2. Results from Logistic Regression Models of 2009 H1N1 Influenza Vaccination

Characteristics	Model 1		Model 2		Model 3	
	AOR‡	95% CI‡	AOR	95% CI	AOR	95% CI
Race/ethnicity						
White, non-Hispanic	1.00		1.00		1.00	
Hispanic, U.S.-born	0.94	(0.77-1.14)	1.05	(0.87-1.27)	1.07	(0.88-1.30)
Hispanic, Foreign-born	0.77**	(0.65-0.90)	1.04	(0.87-1.23)	1.17†	(0.98-1.39)
Sex						
Female	1.00		1.00		1.00	
Male	0.68***	(0.61-0.76)	0.67***	(0.60-0.75)	0.69***	(0.61-0.77)
Age						
65+	1.00		1.00		1.00	
35-64	0.79**	(0.70-0.90)	0.69***	(0.61-0.79)	0.77***	(0.67-0.88)
18-34	0.73**	(0.61-0.88)	0.68***	(0.56-0.82)	0.77**	(0.63-0.93)
Marital Status						
Married	1.00		1.00		1.00	
Not married	0.75***	(0.67-0.86)	0.85*	(0.74-0.98)	0.87†	(0.75-1.00)
Pre-existing Condition						
No	1.00		1.00		1.00	
Yes	1.73***	(1.51-1.98)	1.81***	(1.58-2.08)	1.77***	(1.55-2.03)
Homeownership Status						
Rent, other			1.00		1.00	
Own			1.16*	(1.02-1.31)	1.14*	(1.00-1.29)
Household Income						
$0-$19,999			1.00		1.00	
$20,000-$39,999			1.03	(0.86-1.24)	1.03	(0.86-1.23)
$40,000-$69,999			0.97	(0.81-1.16)	0.93	(0.77-1.11)
$70,000+			1.27*	(1.05-1.55)	1.16	(0.95-1.41)
Education						
Less than High School			1.00		1.00	
High School or GED			1.10	(0.90-1.35)	1.07	(0.87-1.32)
Some College			1.44***	(1.19-1.73)	1.38**	(1.14-1.66)
Bachelor or more			1.92***	(1.57-2.34)	1.78***	(1.46-2.18)
Healthcare Coverage						
No					1.00	
Yes					1.91***	(1.57-2.33)
Valid *n*.§		11,474		11,431		11,411

† p <0.1; *p <0.05; **p <0.01; ***p <0.001.
‡ AOR, adjusted odds ratio; CI, confidence interval.
§ Unweighted sample size.

Characteristics of Foreign-born Hispanics

There is considerable diversity among foreign-born Hispanics in terms of acculturation and social capital. For example, approximately 40% of foreign-born Hispanics are naturalized U.S. citizens. A minority (33.3%) of foreign-born Hispanics responded to the NHIS interview in Spanish, with most responding in either English or some combination of English and Spanish (66.7%). The majority (58.7%) of foreign-born Hispanics report being in the U.S. for 15 years or more; 34.8% of foreign-born Hispanics report being in the U.S. for 5 to 15 years, and only 6.6% report being in the U.S. for less than five years. A strong majority (89.4%) of foreign-born Hispanics in our sample reported Central America (including Mexico) as their region of birth; only 1-in-10 were born in South America.

TABLE 3. Characteristics of foreign-born Hispanics in the 2010 National Health Interview Survey

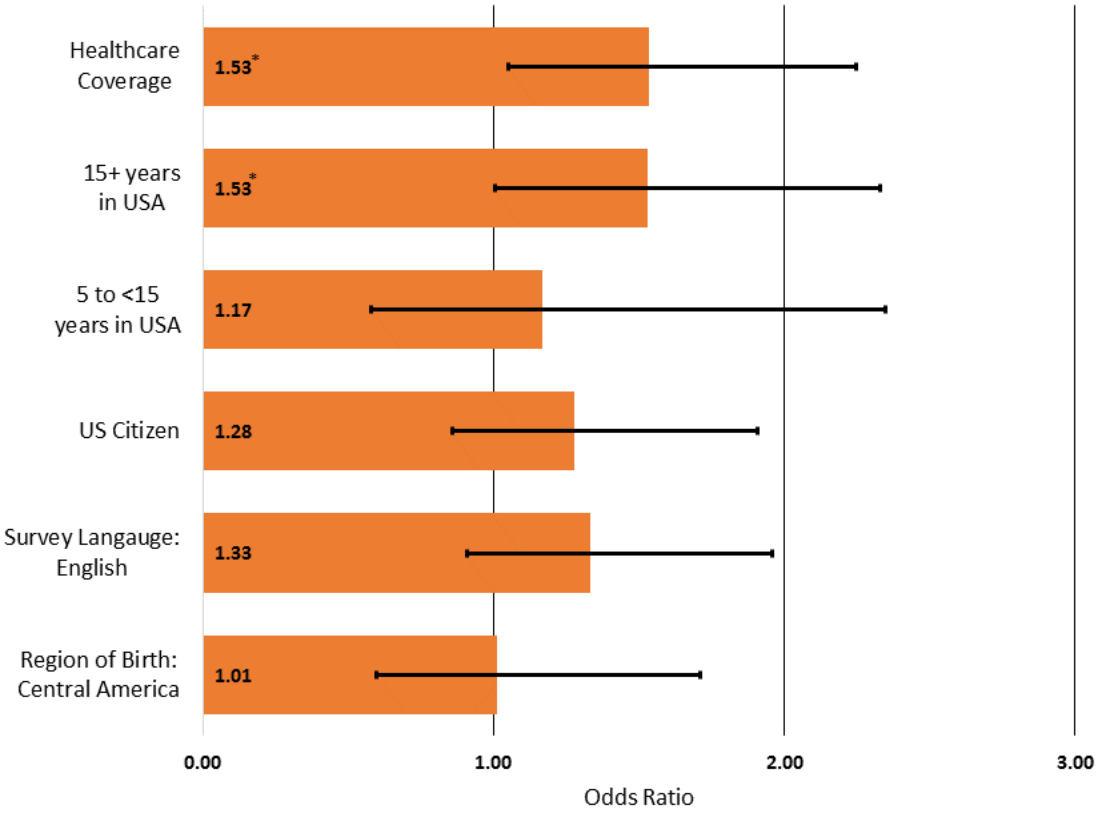
Characteristics	Hispanic, Foreign-born (n=1,912)	
	%	95% CI
Time in the U.S.		
15+ years	58.7	(55.8-61.4)
5 to <15 years	34.8	(32.0-37.7)
< 5 years	6.6	(5.3-8.1)
Citizenship Status		
U.S. Citizen	39.7	(36.7-42.7)
Non-U.S. Citizen	60.3	(57.3-63.3)
Survey Language		
Spanish	33.3	(30.4-36.4)
English	66.7	(63.6-69.6)
Region of Birth		
Central America	89.4	(87.6-91.0)
South America	10.6	(9.0-12.4)

Note: % and CI estimated accounting for complex sampling design of NHIS

Determinants of H1N1 Vaccination Uptake among Foreign-born Hispanics

Figure 1 presents results of a stratified logistic regression model of H1N1 vaccination for foreign-born Hispanics, focusing on the influence of healthcare coverage and migrant-specific characteristics. Among foreign-born Hispanics with healthcare coverage, the odds of H1N1 vaccination were 53% higher than foreign-born Hispanics without healthcare coverage. This result was statistically significant ($p<0.05$), but noticeably weaker than the overall effect of healthcare on H1N1 vaccination in the non-stratified models. Interestingly, the effect of duration of U.S. residency was very similar to the effect of healthcare coverage, with the newest residents at the highest risk of foregoing an H1N1 vaccination. Hispanic migrants who have resided in the United States for 15 years or more were 53% more likely to receive an H1N1 vaccination than those with less than 5 years in the United States ($p<0.05$). While not statistically significant at the $p<0.05$ level, factors such as U.S. citizenship and English language use appear to be associated with higher odds of vaccination. Respondent's region of birth has no effect on the odds of vaccination in our analyses. All other sociodemographic variables included (but not shown) were found to be non-significant at the $p<0.05$ level, except for those at risk of H1N1 complications (adjusted odds ratio (AOR) =1.70, $p<0.001$) and those with some college or an associate's degree (AOR=0.53, $p<0.05$).

FIGURE 1. Results from a Stratified Logistic Regression Model of H1N1 Vaccination among Foreign-Born Hispanics



1. Error bars represent 95% confidence intervals.
2. Reference categories (in descending order): No healthcare coverage, In U.S. for <5 years, Non-US Citizen, Survey Language: Spanish Only,
region of birth: South America.
3. Additional variables controlled for, but not reported: age, sex, marital status, pre-existing conditions, education, household income,
homeownership status.

† p <0.1; *p <0.05; **p <0.01; ***p <0.001

DISCUSSION

Consistent with our expectations, there are important differences between U.S.-born and foreign-born Hispanics. For example, U.S.-born Hispanics tend to exhibit levels of education, income, and healthcare coverage that are more similar to non-Hispanic whites than foreign-born Hispanics. From our analyses, it appears that simple demographic differences may account for low vaccination uptake among U.S.-born Hispanics relative to non-Hispanic whites. Even though younger populations were targeted for H1N1 vaccination, our analysis confirms that older populations were more likely to vaccinate despite economic status or educational attainment. In addition, U.S.-born Hispanics are less likely to be married than non-Hispanic whites—and the unmarried were less likely to receive an H1N1 vaccination. Although descriptive statistics show that U.S.-born Hispanics were vaccinated at a significantly lower rate than non-Hispanic whites, accounting for differences in age, sex, marital status, and pre-existing conditions eliminates the vaccination gap between these groups. Moreover, vaccination disparities between U.S.-born Hispanics and non-Hispanic whites do not change appreciably after accounting for flexible resources and healthcare coverage.

Whereas demographics played an important role in vaccination disparities between U.S.-born Hispanics and non-Hispanic whites, it is clear that insufficient flexible resources and healthcare coverage suppressed H1N1 vaccination uptake among foreign-born Hispanics. As predicted by FCT, lower levels of flexible resources among foreign-born Hispanics strongly influence vaccination uptake. In fact, when resource disparities were controlled in our statistical models, foreign-born Hispanics were actually somewhat

more likely to receive an H1N1 vaccine than non-Hispanic whites. Moreover, foreign-born Hispanics who have resided in the U.S. for a long duration have better odds of vaccination than those who arrived recently, possibly indicating higher levels of acculturation and growth in social capital acquired by living in the U.S. for a longer period of time. Although not quite statistically significant, other indicators of acculturation and social capital (namely citizenship and facility with the English language) have associations with H1N1 vaccination among foreign-born Hispanics that are consistent with FCT.

Another important finding from our study is the powerful impact of healthcare coverage on H1N1 vaccination uptake. While the direct mechanism linking healthcare coverage to higher odds of vaccination is unknown, we doubt that lower out-of-pocket vaccination costs for those with insurance played a significant role because the 2009 H1N1 vaccine was heavily subsidized by the U.S. Government. Healthcare coverage may provide an important source of information and motivation, however, since individuals with health insurance typically have more interactions with healthcare providers and familiarity with procedures to obtain services (DeVoe et al. 2003). While we acknowledge that the U.S. must address deep structural disparities in education and other flexible resources to produce optimal population health, in the short-term it appears that expanding healthcare coverage would be an effective way to increase vaccination uptake during pandemic influenzas.

As with all studies involving minority populations, adequate sample coverage can be an issue. However, a strength of our investigation is that the NHIS sampling design

produced a sample of U.S.-born and foreign-born Hispanics that is comparable to these populations in the 2009 American Community Survey (ACS) (Pew Hispanic Center 2011). However, it is likely that both the NHIS and ACS are inadequate in their coverage of transient and economically disadvantaged foreign-born Hispanics, resulting in an overestimation of H1N1 vaccination among foreign-born Hispanics and underestimation of reported resource disparities when compared to non-Hispanic whites.

Another strength of the NHIS data used in our study is the presence of multiple health indicators, giving us the ability to examine certain groups that the CDC urged to receive the 2009 H1N1 vaccine, including those with pre-existing conditions such as diabetes and asthma. Unfortunately, however, the NHIS data do not contain sufficient detail to provide separate estimates for all "at-risk" groups identified by the CDC, including (1) household contacts or caregivers of children younger than 6 months of age, and (2) those working in healthcare or emergency medical services.

CONCLUSION

With much of the global population, especially the young, having no prior immune response to the 2009 H1N1 virus, this pandemic influenza created a substantial global morbidity and mortality burden (Dawood et al. 2012; Kerkhove et al. 2013). Indeed, the H1N1 pandemic produced a considerable loss of life-years (Simonsen et al. 2013), some of which likely could have been prevented through better vaccination practices (Miller et al. 2008). Given the urgent response of the United States government to the H1N1 pandemic and the difficulty in achieving its vaccination objectives (as

evidenced by low rates of H1N1 vaccination), the 2009 H1N1 virus provides the public health community with an excellent case-study in addressing barriers to pandemic vaccination.

By differentiating between U.S.-born and foreign-born Hispanics, our investigation provides a nuanced view of Hispanic vaccination behavior during the 2009 H1N1 pandemic. While both U.S.-born and foreign-born Hispanics were less likely than non-Hispanic whites to receive the H1N1 vaccination, the mechanisms explaining those disparities differ by nativity status. Lower H1N1 vaccination among U.S.-born Hispanics appears to be related to differences in demographics, particularly age and marital status. Conversely, foreign-born Hispanics were less likely to receive the H1N1 vaccine than non-Hispanic whites due to fewer flexible resources such as education and income, and poorer healthcare coverage. Understanding how these mechanisms differ across groups of Hispanics is vital for improving public health policies and practices designed to improve vaccination uptake during future influenza pandemics.

REFERENCES

Acevedo-Garcia, Dolores, Mah-J Soobader, and Lisa F Berkman. 2007. "Low Birthweight among US Hispanic/Latino Subgroups: the Effect of Maternal Foreign-Born Status and education." *Social Science & Medicine* 65(12):2503-16.

Blumenshine, P., A. Reingold, S. Egerter, R. Mockenhaupt, P. Braveman, and J. Marks. 2008. "Pandemic Influenza Planning in the United States from a Health Disparities Perspective." *Emerging Infectious Diseases* 14(5):709-15.

Burger, Andrew E. and Eric N. Reither. 2014. "Monitoring Receipt of Seasonal Influenza Vaccines with BRFSS and NHIS data: Challenges and Solutions." *Vaccine* 32(31):3950-54.

Centers for Disease Control and Prevention. 2009. "Serum Cross-Reactive Antibody Response to a Novel Influenza A(H1N1) Virus after Vaccination with Seasonal Influenza Vaccine." *Morbidity and Mortality Weekly Report* 58(19):521-24.

Centers for Disease Control and Prevention. 2011. "Final Estimates for 2009-10 Seasonal Influenza and Influenza A(H1N1) 2009 Monovalent Vaccination Coverage - United States, August 2009 through May, 2010." (https://www.cdc.gov/flu/fluvaxview/coverage_0910estimates.htm).

Centers for Disease Control and Prevention. 2015. "Variance estimation guidance, NHIS 2006-2014 (adapted from the 2006-2014 NHIS survey description documents)."

Dawood, Fatimah S., A. Danielle Iuliano, Carrie Reed, Martin I. Meltzer, David K. Shay, Po-Yung Cheng, Don Bandaranayake, Robert F. Breiman, W. Abdullah Brooks, and Philippe Buchy. 2012. "Estimated Global Mortality Associated with the First

12 Months of 2009 Pandemic Influenza A H1N1 Virus Circulation: a Modelling Study." *The Lancet Infectious Diseases* 12(9):687-95.

Dee, Deborah L., Diana M. Bensyl, Jacqueline Gindler, Benedict I. Truman, Barbara G. Allen, Tiffany D'Mello, Alejandro Pérez, Laurie Kamimoto, Matthew Biggerstaff, and Lenee Blanton. 2011. "Racial and Ethnic Disparities in Hospitalizations and Deaths Associated with 2009 Pandemic Influenza A (H1N1) Virus Infections in the United States." *Annals of Epidemiology* 21(8):623-30.

DeVoe, Jennifer E., George E. Fryer, Robert Phillips, and Larry Green. 2003. "Receipt of Preventive Care among Adults: Insurance Status and Usual Source of Care." *American Journal of Public Health* 93(5):786-91.

Keene, Danya E., Julia F. Lynch, and Amy Castro Baker. 2014. "Fragile Health and Fragile Wealth: Mortgage Strain among African American Homeowners." *Social Science & Medicine* 118:119-26.

Kerkhove, Maria D., Siddhivinayak Hirve, Artemis Koukounari, and Anthony W. Mounts. 2013. "Estimating Age-Specific Cumulative Incidence for the 2009 Influenza Pandemic: a Meta-Analysis of A (H1N1) pdm09 Serological Studies from 19 countries." *Influenza and Other Respiratory Viruses* 7(5):872-86.

Kohler, Adriana D, and Melissa Lazarín. 2007. "Hispanic Education in the United States." *Statistical Brief* 8:1-16.

Kwan-Gett, Tao Sheng, Atar Baer, and Jeffrey S Duchin. 2009. "Spring 2009 H1N1 influenza outbreak in King County, Washington." *Disaster Medicine and Public Health Preparedness* 3(S2):S109-S16.

Link, Bruce G., and Jo C. Phelan. 1995. "Social Conditions as Fundamental Causes of Disease." *Journal of Health and Social Behavior* Spec no:80-94.

Lu, Peng-jun, Alfonso Rodriguez-Lainz, Alissa O'Halloran, Stacie Greby, and Walter W Williams. 2014. "Adult Vaccination Disparities among Foreign-Born Populations in the US, 2012." *American journal of preventive medicine* 47(6):722-33.

Mamelund, Svenn-Erik. 2011. "Geography May Explain Adult Mortality from the 1918–20 Influenza Pandemic." *Epidemics* 3(1):46-60.

Miller, Mark A., Cecile Viboud, Donald R. Olson, Rebecca F. Grais, Maia A. Rabaa, and Lone Simonsen. 2008. "Prioritization of Influenza Pandemic Vaccination to Minimize Years of Life Lost." *Journal of Infectious Diseases* 198(3):305-11.

Miller, Russell.R., Boaz A. Markewitz, Robert T. Rolfs, Samuel M. Brown, Kristin K. Dascomb, Colin K. Grissom, Michael D. Friedrichs, Jeanmarie Mayer, Eliotte L. Hirshberg, and Jamie Conklin. 2010. "Clinical Findings and Demographic Factors Associated with ICU Admission in Utah due to Novel 2009 Influenza A (H1N1) Infection." *Chest* 137(4):752.

Navaranjan, Debeka, Laura C Rosella, Jeffrey C Kwong, Michael Campitelli, and Natasha Crowcroft. 2014. "Ethnic Disparities in Acquiring 2009 Pandemic H1N1 Influenza: a Case–Control Study." *BMC Public Health* 14(1):1.

Nichol, Kristin L, and John J Treanor. 2006. "Vaccines for Seasonal and Pandemic Influenza." *Journal of Infectious Diseases* 194(Supplement 2):S111-S18.

Pabon-Nau, Lina P, Amy Cohen, James B Meigs, and Richard W Grant. 2010. "Hypertension and Diabetes Prevalence among US Hispanics by Country of

Origin: the National Health Interview Survey 2000-2005." *Journal of General Internal Medicine* 25(8):847-52.

Pew Hispanic Center. 2011. "Statistical portrait of Hispanics in the United States, 2009." Pew Hispanic Center.

Phelan, Jo C., and Bruce G. Link. 2005. "Controlling Disease and Creating Disparities: a Fundamental Cause Perspective." *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 60(Special Issue 2):S27.

Quinn, Sandra Crouse, Supriya Kumar, Vicki S Freimuth, Donald Musa, Nestor Casteneda-Angarita, and Kelley Kidwell. 2011. "Racial Disparities in Exposure, Susceptibility, and Access to Health Care in the US H1N1 Influenza Pandemic." *American Journal of Public Health* 101(2):285.

Ritger, KA, RC Jones, KN Weaver, E Ramirez, S Smith, JY Morita, CJ Lohff, SB Black, JD Jones, and W Wong. 2009. "2009 Pandemic Influenza A (H1N1) Virus Infections-Chicago, Illinois, April-July 2009." *Morbidity and Mortality Weekly Report* 58(33):913-18.

Shrestha, Sundar S., David L. Swerdlow, Rebekah H. Borse, Vimalanand S. Prabhu, Lyn Finelli, Charisma Y. Atkins, Kwame Owusu-Edusei, Beth Bell, Paul S. Mead, Matthew Biggerstaff, Lynnette Brammer, Heidi Davidson, Daniel Jernigan, Michael A. Jhung, Laurie A. Kamimoto, Toby L. Merlin, Mackenzie Nowell, Stephen C. Redd, Carrie Reed, Anne Schuchat, and Martin I. Meltzer. 2011. "Estimating the Burden of 2009 Pandemic Influenza A (H1N1) in the United

States (April 2009–April 2010)." *Clinical Infectious Diseases* 52(suppl 1):S75-S82.

Simonsen, Lone, Peter Spreeuwenberg, Roger Lustig, Robert J Taylor, Douglas M Fleming, Madelon Kroneman, Maria D Van Kerkhove, Anthony W Mounts, and W John Paget. 2013. "Global Mortality Estimates for the 2009 Influenza Pandemic from the GLaMOR Project: A Modeling Study." *PLoS Med* 10(11):e1001558.

StataCorp, LP. 2017. "Stata 15." StataCorp LP., College Station, Texas, United States. http://www.stata.com.

Suro, R., and J.S. Passel. 2003. *The Rise of the Second Generation: Changing Patterns in Hispanic Population Growth*: Pew Hispanic Center Washington, DC.

Thompson, Deborah L., Jessica Jungk, Emily Hancock, Chad Smelser, Michael Landen, Megin Nichols, David Selvage, Joan Baumbach, and Mack Sewell. 2011. "Risk Factors for 2009 Pandemic Influenza A (H1N1)-Related Hospitalization and Death among Racial/Ethnic Groups in New Mexico." *American Journal of Public Health* 101(9):1776-84.

Tognotti, Eugenia. 2009. "Influenza Pandemics: A Historical Retrospect." *The Journal of Infection in Developing Countries* 3(5):331-34.

Truelove, Shaun A., Amit S. Chitnis, Richard T. Heffernan, Amy E. Karon, Thomas E. Haupt, and Jeffrey P. Davis. 2011. "Comparison of Patients Hospitalized with Pandemic 2009 Influenza A (H1N1) Virus Infection during the First Two Pandemic Waves in Wisconsin." *Journal of Infectious Diseases* 203(6):828-37.

Umaña-Taylor, A.J., and M.A. Fine. 2001. "Methodological Implications of Grouping Latino Adolescents into One Collective Ethnic Group." *Hispanic Journal of Behavioral Sciences* 23(4):347-62.

Uscher-Pines, Lori, Jurgen Maurer, and Katherine Harris. 2011. "Racial and Ethnic Disparities in Uptake and Location of Vaccination for 2009-H1N1 and Seasonal Influenza." *American Journal of Public Health*. 101(7):1252-1255.

APPENDIX

Copyright Transfer Statement (CTS) for your article in Journal of Immigrant and Minority Health (594)

Thu, Apr 27, 2017 at 2:41 PM

Copyright Transfer

27.04.2017

visit us at springer.com

Confirmation of your Copyright Transfer

Dear Author,

Please note: This e-mail is a confirmation of your copyright transfer and was sent to you only for your own records.

The copyright to this article, including any graphic elements therein (e.g. illustrations, charts, moving images), is hereby assigned for good and valuable consideration to Springer Science+Business Media New York effective if and when the article is accepted for publication and to the extent assignable if assignability is restricted for by applicable law or regulations (e.g. for U.S. government or crown employees). Author warrants (i) that he/she is the sole owner or has been authorized by any additional copyright owner to assign the right, (ii) that the article does not infringe any third party rights and no license from or payments to a third party is required to publish the article and (iii) that the article has not been previously published or licensed.

The copyright assignment includes without limitation the exclusive, assignable and sublicensable right, unlimited in time and territory, to reproduce, publish, distribute, transmit, make available and store the article, including abstracts thereof, in all forms of media of expression now known or developed in the future, including pre- and reprints, translations, photographic reproductions and microform. Springer may use the article in whole or in part in electronic form, such as use in databases or data networks for display, print or download to stationary or portable devices. This includes interactive and multimedia use and the right to alter the article to the extent necessary for such use.

Authors may self-archive the Author's accepted manuscript of their articles on their own websites. Authors may also deposit this version of the article in any repository, provided it is only made publicly available 12 months after official publication or later. He/she may not use the publisher's version (the final article), which is posted on SpringerLink and other Springer websites, for the

Article Details

Journal title	**Article title**
Journal of Immigrant and Minority Health	The Influence of Hispanic Ethnicity and Nativity Status on 2009 H1N1 Pandemic Vaccination Uptake in the United States
DOI	**Corresponding Author**
10.1007/s10903-017-0594-4	Andrew Burger
Copyright transferred to	**Transferred on**
Springer Science+Business Media New York	Thu Apr 27 22:41:14 CEST 2017

Service Contacts

Springer Customer Service Center

Tiergartenstr. 15-17
69121 Heidelberg
Germany
phone: +49 6221 345 0
fax: +49 6221 345 4229
customerservice@springer.com

Springer New York, LCC

233 Spring Street
New York, NY 10013
USA
phone: +1 212 460 1500 or 800-SPRINGER
(Weekdays 8:30am - 5:30pm ET)
fax: +1 212-460-1700
customerservice@springer.com

PAPER 2

THE IMPACT OF GENDER AND RACIAL IDENTIFICATION ON H1N1 VACCINATION BELIEFS AND BEHAVIORS IN THE UNITED STATES

ABSTRACT

Background: In the United States, there were vaccination disparities during the 2009 H1N1 pandemic by gender and racial identification. This study contributes to this literature by considering how socioeconomic status (SES) and measures from the Health Belief Model affect gender and race disparities in vaccination uptake.

Methods: Using data from the National H1N1 Flu Survey, a representative sample of U.S. non-institutionalized adults administered by the Centers for Disease Control and Prevention, I examine vaccination disparities between non-Hispanic white and non-Hispanic black (hereafter white and black) males and females. In addition to various descriptive statistics, I estimate a series of nested logistic regression models to examine how demographic characteristics, measures of SES, and various health-related indicators (e.g., insurance, chronic conditions and beliefs about vaccination) may explain race-gender disparities in vaccination uptake.

Results: White females report the highest rate of H1N1 vaccination (28.4%), followed by white males (26.3%), black males (21.6%) and black females (17.5%). All of these race-gender differences are statistically significant ($p<0.05$) in an age-adjusted model. Introducing SES, health insurance status and health conditions fully account for

vaccination differences between white females and white and black males. However, a stark disadvantage in vaccination uptake persists among black females when compared to white females, even after controlling for various beliefs about H1N1 and the efficacy of vaccination.

Discussion: The intersection of race and gender is a crucial consideration in identifying at-risk populations for low vaccination. Improving educational attainment and access to health insurance could nearly eliminate disadvantages in H1N1 vaccination experienced by black men. However, my findings suggest that targeted outreach programs may be necessary to improve vaccine uptake among black women in future pandemics.

BACKGROUND

As the first novel-strain influenza outbreak in decades, the 2009 H1N1 pandemic created a substantial burden of excess morbidity and mortality. Between April 2009 and April 2010 in the United States, there were an estimated 60.8 million cases of H1N1, 274,304 hospitalizations, and 12,469 deaths attributable to the outbreak (Shrestha et al. 2011). While evidence suggests that older populations experienced some immunological protection against the 2009 H1N1 virus (Mamelund 2011), most of the population was at heightened risk of infection due to the novel nature of the virus. Efforts to vaccinate the U.S. population became an important part in preventing and reducing the disease burden of H1N1. With an effectiveness estimated at around 69% (Osterholm et al. 2012), the 2009 monovalent H1N1 vaccine significantly reduced the risk of infection and serious outcomes including hospitalizations and death.

The United States federal government approved emergency funding in excess of $6 billion USD to facilitate emergency production of the 2009 H1N1 vaccine and promote awareness of the pandemic (GAO 2011). With this funding, the 2009 H1N1 monovalent vaccine was federally subsidized and provided to health agencies at no cost (CDC 2009a). Although the H1N1 vaccination was in short supply during the early phases of the pandemic, prompting the CDC to prioritize high-risk populations, it was available to anyone who wanted it by late December 2009 (CDC 2010).

Despite its widespread availability, vaccine uptake was low in the U.S. population, even among groups at highest risk for H1N1 complications (CDC 2011; Galarce, Minsky and Viswanath 2011). Understanding the causes of low vaccination

rates may provide important lessons in preparing for a future influenza pandemic, which will inevitably occur (Russell and Webster 2005). A consistent theme in public health research is persistent disparities in health and health-related behaviors—including vaccination uptake—by sociodemographic characteristics (Braveman et al. 2005; Braveman et al. 2010; Link and Phelan 1995; Morton and Ferraro 2014; Strecher, Champion and Rosenstock 1997). Such disparities existed during the 2009 H1N1 pandemic, with racial/ethnic minorities in the U.S. reporting lower vaccination rates than non-Hispanic whites (Burger et al. 2017; Dee et al. 2011; Quinn et al. 2011; Uscher-Pines, Maurer and Harris 2011). Fewer studies have examined differences in vaccination by gender, despite evidence showing that females were at higher risk of exposure and health complications during the pandemic (Klein et al. 2010).

It is likely that low rates of vaccination led to an increased burden of H1N1-related morbidity and mortality among non-Hispanic blacks compared to non-Hispanic whites in the U.S. (Thompson et al. 2011). This study extends prior research on vaccination disparities during the 2009 H1N1 pandemic by considering how race intersects with gender to influence vaccination behavior. Through an exploration of mechanisms such as socioeconomic status and health beliefs, this investigation also explains *why* vaccination disparities exist by race and gender.

Intersectionality of Race/Ethnicity and Gender

Racial and ethnic disparities in influenza vaccination receive considerable attention in academic research; however, the World Health Organization in a 2010 report urged further research be conducted on the association between gender and influenza

vaccination behavior (WHO 2010). Moreover, traditional health analyses tend to examine social identities, such as race and gender, as separate variables, which may limit understanding of how these identities jointly affect life experiences (Krieger et al. 1993). This poses a serious limitation since intersectionality theory suggests that social identities are codependent on each other. The experience of a white woman and a black woman may be different because of the combined experience of race and gender or the intersection of the two identities. These multiple identities, and their interaction at the individual level, can then shape interactions at the structural level to influence health (Bowleg 2012). Given the literature on the intersectionality of race and gender and their influence on health (Bauer 2014; Hankivsky 2012), it is reasonable to expect that exploring the combined influence of gender and race will provide a more nuanced view of vaccination uptake. For instance, I expect that black females, who experience the highest rate of household poverty in this study, will experience more barriers to vaccination than black males or whites of either gender.

Socioeconomic Status

Socioeconomic status (SES) is a powerful predictor of health and health behaviors (DeNavas-Walt, Proctor and Smith 2011). Previous research on seasonal influenza vaccination suggests that household income and employment are important determinants of vaccination uptake (Armstrong et al. 2001; Gargano et al. 2011; Vlahov et al. 2012). Interestingly, during the H1N1 pandemic, some studies found that income is not a predictor of vaccination uptake (Burger et al. 2017; Galarce, Minsky and Viswanath 2011). In the case of the H1N1 pandemic, this may be attributable to subsidization of the

vaccine by the U.S. government. Nevertheless, I account for potential income effects as well as other measures of SES that may influence vaccination behaviors, including education and health insurance – which may provide the gateway to healthcare utilization even when medical interventions are free to the public (Kumar et al. 2012).

At-Risk Populations

During the 2009 H1N1 pandemic, the CDC's Advisory Committee on Immunization Practices (ACIP) urged vaccination for the following groups: pregnant women; healthcare workers and emergency medical services personnel; persons in close contact with infants aged <6 months; persons aged 6 months to 24 years; and persons aged 25-64 with medical conditions that increase susceptibility to H1N1-related complications (CDC 2009b). In addition, the ACIP recommended that in the event of limited vaccination supplies (which occurred during the 2009 H1N1 pandemic), the highest priority should be given to pregnant women, persons in contact with infants <6 months of age, children aged 6 months through 4 years, and children aged 5-18 with certain medical conditions. After vaccination supplies improved in late 2009, states began to open vaccination to the broader population (CDC 2010). Demographic, epidemiological, and employment surveys indicate that many of the risk factors mentioned above (i.e., being in close contact with a child <6 months of age, certain medical conditions, and employment as a healthcare worker) were unequally distributed by race and gender in the U.S. during the pandemic (BLS 2010; Freid, Bernstein and Bush 2012; NCHS 2011; Siordia 2015).

Health Care Access and Encounters

Previous work finds health insurance to be a powerful predictor of vaccination among Hispanics (Burger et al. 2017), but fewer studies have focused specifically on non-Hispanics blacks. I therefore consider healthcare coverage as a potential mediator of black-white disparities in H1N1 vaccination, as it may provide resources, information, and access to the vaccine. In addition to healthcare coverage, I examine the role that vaccine recommendations from a healthcare provider play in the decision to vaccinate against H1N1.

Health Belief Model

Combining stimulus-response theory and cognitive theory, the HBM asserts that perceptions of risks, benefits, and barriers have an important influence on health behaviors (Strecher, Champion and Rosenstock 1997). Specific perceptions measured by the HBM include perceived susceptibility to a health condition, perceived severity of the condition, perceived barriers to treatment, and perceived benefits of treatment (Champion and Skinner 2008). Prior studies have used HBM to explain racial and/or gender disparities in a wide variety of health behaviors, ranging from help-seeking intentions during psychological distress (Kim and Zane 2016) to the correct replacement of daily disposable contact lenses (Livi, Zeri and Baroni 2017). A few studies have employed the HBM to help explain H1N1 vaccination uptake in local populations (Coe, Gatewood and Moczygemba 2012; Frew et al. 2012; Gargano et al. 2011), but to my knowledge no study has yet evaluated the extent to which health beliefs account for race-gender

disparities in H1N1 vaccination uptake in the United States using a nationally representative sample. By combining "standard" SES-related explanations with measures of risk status for H1N1 complications as well as individual perceptions of health behavior provided by HBM, I hope to explain race and gender disparities in H1N1 vaccination.

METHODS

Data

The National H1N1 Flu Survey (NHFS) represents a concerted effort to study the 2009 H1N1 pandemic in the U.S. through a collaboration between the National Center for Immunization and Respiratory Disease (NCRID), the National Center for Health Statistics (NCHS), and the Centers for Disease Control and Prevention (CDC). Administered from October 2009 through June 2010, data from the NHFS provide nationally representative estimates of H1N1 vaccination. In addition to data on H1N1 vaccination uptake, the NHFS includes measures of sociodemographic characteristics and health status—as well as survey items that align with HBM constructs, such as perceptions about the safety and efficacy of the H1N1 vaccine.

Measures

Dependent Variable. The NHFS asked respondents if they received the separately administered H1N1 vaccination as well as the mode of vaccination (shot or nasal spray). Because this study is concerned with vaccination receipt and not the mode of vaccination, I code both nasal spray and intradermal shots as a vaccination. As noted, the vaccine was not available in the general population until the end of 2009. Therefore, to reduce bias in

the analysis from the inclusion of false negatives (i.e. individuals who eventually received the vaccine, but were not vaccinated at the time of the survey) I limit the analyses to respondents who were interviewed between January 2010 and June 2010 – an approach validated in the estimation of seasonal influenza vaccinations in Burger and Reither (2014).

Independent Variables. I create a composite variable that combines gender and race into four separate groups: white males; white females; black males; and black females. Additionally, the NHFS includes socio-demographic characteristics that I include in the analysis. Allowing for comparisons between younger populations (which were at greater risk of H1N1 infection) and the older population, I categorize age into three groups: 18-34; 34-64; and 65+. I collapse educational attainment into four levels: less than 12 years of formal schooling; 12 years of schooling (equivalent to a high school degree in most cases); some college; and college graduate. The NHFS provides a convenient measure of SES through a three-level annual household income/poverty measure: below poverty; above poverty but <=$75,000; and >$75,000. I considered additional measures of SES such as employment status and home ownership, but inclusion of these variables did not improve the explanatory power of my regression models. Therefore, I excluded these variables in the final analyses.

Within the NHFS is a bivariate indicator of chronic health conditions that I use in the analyses. This variable includes asthma or other lung conditions, a kidney condition, sickle cell anemia or other anemia, neurological or neuromuscular conditions, liver conditions, or a weakened immune system caused by chronic illness or medicines taken for a chronic illness). In addition, the NHFS includes dichotomous variables to indicate

whether an individual (1) has regular contact with children under 6 months of age, and (2) is a health care worker with regular direct patient contact. I include these variables in the study as predictors of vaccine uptake. Also included in my analysis is a binary measure of self-reported healthcare coverage. In addition, I include a self-reported measure of whether the respondent received a doctor's recommendation to receive the H1N1 vaccine – a question asked of all respondents regardless of whether or not they reported going to a doctor.

Unique among large publicly available health surveys, the NHFS includes several items that reflect important HBM theoretical constructs. The NHFS asks respondents (1) how concerned they are about H1N1 (*perceived severity*), (2) how likely it is that they will become sick from H1N1 *(perceived susceptibility*), (3) how worried they are about getting sick from the H1N1 vaccination (*perceived barrier*), and (4) how effective they believe the H1N1 vaccination is in preventing disease (*perceived benefit).* The NHFS records all of these measures using a four-point balanced Likert type scale, which I collapse into two categories due to low cell sizes and to ease the interpretation of the analysis. I code dummy-variables to indicate attitudes that are either favorable or unfavorable to H1N1 vaccination.

Analyses

All of the analyses account for the complex sampling design of the NHFS. I begin by estimating H1N1 vaccination uptake across race/sex groups and other predictor variables using STATA 14 (StataCorp 2017). I then estimate a series of nested, binary logistic regression models in Mplus 8 (Muthén and Muthén 2017). These models use full-

information maximum likelihood (FIML) estimation to address issues with missing data found within the NHFS. In most cases, FIML is a preferable approach to addressing missing data than listwise deletion because it makes weaker assumptions about patterns of missing data. In addition, FIML has clear advantages in terms of statistical power (Dong and Peng 2013). Listwise deletion would exclude approximately 40% of available cases in the final model, inflating standard errors and potentially introducing bias.

Using a nested model approach, I am able to test the extent to which the mediating variables, including SES and HBM-related variables, account for the effect of race and gender. In model 1, I estimate the effect of race/sex, while controlling for the age of the respondent. Model 2 introduces socioeconomic measures (poverty status, education, and marital status) which may partly attenuate the effects of race/sex and age. Model 3 includes variables representing high-risk groups identified by the CDC: individuals who have frequent close contact with infants less than 6 months of age; healthcare workers; and those with at least one chronic condition. Model 4 introduces health insurance coverage and a measure of whether the respondent's doctor recommended the vaccine. Model 5 enters the HBM variables into the analysis, allowing me to observe the extent to which health beliefs mediate the association between race/sex and vaccination uptake.

RESULTS

Sociodemographic Characteristics and H1N1 Vaccination

Overall, rates of H1N1 vaccination are low (Table 1). Among the four race/sex groups I evaluated, white females were the most likely to report vaccination against

H1N1 (28.4%) and black females the least (17.5%). In addition, the descriptive statistics indicate that black men and women in this study tend to be younger than white female and male counterparts. Other notable differences by race and sex include a higher percentage of black females and males below the poverty line (32.3% and 26.4% respectively) than whites. Educational attainment tends to be lower among blacks than whites, regardless of gender. The share of blacks that are married is considerably lower than whites, with 28.3% of black females reporting being currently married. Blacks are also much less likely than whites to have health insurance. For example, 20.3% of black females report no health insurance, compared to 9.5% of white females. When examining populations the CDC specifically recommended for vaccination, I observe a higher percentage of black females who are in contact with children under 6 months of age (11.7%), healthcare workers (22.5%), and report a chronic condition (29.8%) than the other race/sex groups in this analysis.

TABLE 1. Descriptive Statistics for H1N1 Vaccination and Sociodemographic Characteristics of Respondents in the National H1N1 Flu Survey (NHFS)

Characteristics	White Female			White Male			Black Female			Black Male		
	%	95% CI -/+		%	95% CI -/+		%	95% CI -/+		%	95% CI -/+	
H1N1 Vaccination												
Yes	28.4%	27.2%	29.5%	26.3%	25.0%	27.7%	17.5%	14.8%	20.6%	21.6%	17.7%	26.1%
No	71.6%	70.5%	72.8%	73.7%	72.3%	75.0%	82.5%	79.4%	85.2%	78.4%	73.9%	82.3%
Valid n		17,846			12,197			1,997			1,125	
Age												
65+	21.4%	20.5%	22.3%	18.1%	17.1%	19.1%	15.6%	13.3%	18.3%	13.6%	11.0%	16.6%
35-64	53.1%	51.9%	54.4%	56.0%	54.5%	57.5%	51.9%	48.0%	55.7%	51.2%	46.1%	56.2%
18-34	25.5%	24.2%	26.7%	25.9%	24.5%	27.4%	32.5%	28.8%	36.4%	35.2%	30.3%	40.5%
Valid n		17,907			12,266			2,013			1,143	
Poverty Status												
Below poverty	10.1%	9.2%	10.9%	6.7%	5.9%	7.6%	32.3%	28.4%	36.3%	26.4%	21.2%	32.3%
<=$75,000	56.0%	54.6%	57.4%	52.8%	51.2%	54.5%	51.1%	46.9%	55.2%	54.8%	49.2%	60.3%
>$75,000	33.9%	32.6%	35.3%	40.5%	38.8%	42.1%	16.7%	13.7%	20.1%	18.8%	15.0%	23.2%
Valid n		14,885			10,375			1,623			898	
Education												
< 12 Years	7.4%	6.7%	8.2%	6.3%	5.6%	7.1%	14.1%	11.8%	16.8%	14.4%	11.6%	17.9%
12 Years	22.0%	20.9%	23.0%	20.8%	19.6%	22.0%	25.2%	21.9%	28.7%	30.1%	25.8%	34.9%
Some Coll.	29.4%	28.2%	30.6%	26.6%	25.2%	27.9%	36.4%	32.4%	40.6%	33.4%	28.6%	38.6%
Coll. Grad	41.2%	40.0%	42.5%	46.3%	44.8%	47.9%	24.3%	21.4%	27.6%	22.0%	18.4%	26.1%
Valid n		17,078			11,550			1,895			1,068	
Marital Status												
Not Married	41.6%	40.3%	42.9%	39.8%	38.3%	41.4%	71.7%	68.1%	75.0%	62.6%	57.4%	67.5%
Married	58.4%	57.1%	59.7%	60.2%	58.6%	61.7%	28.3%	25.0%	31.9%	37.4%	32.5%	42.6%
Valid n		17,036			11,548			1,882			1,065	

Note: % and confidence interval (CI) estimates account for the NHFS complex sampling design
Valid *n*=unweighted sample

TABLE 1 (Continued). Descriptive Statistics for H1N1 Vaccination and Sociodemographic Characteristics of Respondents in the National H1N1 Flu Survey (NHFS)

Characteristics	White Female			White Male			Black Female			Black Male		
	%	95% CI -/+		%	95% CI -/+		%	95% CI -/+		%	95% CI -/+	
Close Contact with Child <6 months												
No	90.5%	89.7%	91.3%	92.2%	91.2%	93.1%	88.3%	85.4%	90.7%	92.7%	90.1%	94.6%
Yes	9.5%	8.7%	10.3%	7.8%	6.9%	8.8%	11.7%	9.3%	14.6%	7.3%	5.4%	9.9%
Valid n		17,355			11,840			1,934			1,106	
Healthcare Worker												
No	82.1%	81.0%	83.1%	89.5%	88.3%	90.5%	77.5%	73.7%	80.9%	90.9%	87.5%	93.4%
Yes	17.9%	16.9%	19.0%	10.5%	9.5%	11.7%	22.5%	19.1%	26.3%	9.1%	6.6%	12.5%
Valid n		17,331			11,823			1,932			1,101	
Chronic Condition												
No	71.4%	70.2%	72.5%	76.3%	75.0%	77.5%	66.5%	62.7%	70.2%	76.7%	72.2%	80.6%
Yes	28.6%	27.5%	29.8%	23.7%	22.5%	25.0%	33.5%	29.8%	37.3%	23.3%	19.4%	27.8%
Valid n		17,248			11,789			1,914			1,095	
Health Insurance Status												
No	9.5%	8.6%	10.5%	11.9%	10.8%	13.0%	20.3%	16.5%	24.7%	29.0%	23.8%	34.9%
Yes	90.5%	89.5%	91.4%	88.1%	87.0%	89.2%	79.7%	75.3%	83.5%	71.0%	65.1%	76.2%
Valid n		14,635			9,822			1,592			899	
Dr. Recommended Vaccine												
No	75.32%	74.22%	76.39%	79.97%	78.68%	81.20%	74.66%	71.21%	77.83%	78.62%	73.69%	82.84%
Yes	24.68%	23.61%	25.78%	20.03%	18.80%	21.32%	25.34%	22.17%	28.79%	21.38%	17.16%	26.31%
Valid n		17,805			12,191			2,002			1,135	

Note: % and confidence interval (CI) estimates account for the NHFS complex sampling design
Valid *n*=unweighted sample

Health Beliefs

In Table 2, I present descriptive statistics for the survey items used to measure concepts in the HBM. General concern regarding H1N1 appears to be higher among blacks, with almost 2 out of every 3 black females and males reporting a high level of concern. Among whites, concern was particularly low among males. While I find substantial differences in concern about H1N1, differences between whites and blacks are much smaller with respect to the perceived risk of individual infection. Whereas measures of perceived severity and susceptibility deal with the H1N1 virus, measures of perceived barriers and benefits refer to the vaccine. Blacks, on average, tended to be more concerned than whites about potential adverse effects from the H1N1 vaccine. For example, 22.2% of white males were concerned about getting sick from the vaccine, compared to 34.9% of black males. Both whites and blacks generally agreed that the vaccine provided some benefit in preventing disease and is effective, but more than 1 in 5 black females felt the vaccine was not effective. I observe little difference in doctor recommendations to vaccinate by race/sex.

TABLE 2. Descriptive Statistics for H1N1 Vaccination and Health Belief Model (HBM) Components of Respondents in the National H1N1 Flu Survey (NHFS)

Characteristics	White Female			White Male			Black Female			Black Male		
	%	95% CI -/+		%	95% CI -/+		%	95% CI -/+		%	95% CI -/+	
How Concerned about H1N1 (HBM: Severity)												
Low Concern	46.2%	44.9%	47.4%	59.0%	57.5%	60.5%	31.9%	28.4%	35.7%	39.5%	34.6%	44.7%
High Concern	53.9%	52.6%	55.1%	41.0%	39.5%	42.5%	68.1%	64.4%	71.6%	60.5%	55.3%	65.4%
Valid n		17,844			12,227			2,003			1,132	
Risk of Getting Sick with H1N1 (HBM: Susceptibility)												
Low Risk	71.2%	70.0%	72.4%	80.7%	79.5%	81.9%	73.2%	69.5%	76.6%	73.9%	69.2%	78.1%
High Risk	28.8%	27.6%	30.0%	19.3%	18.1%	20.6%	26.8%	23.4%	30.5%	26.1%	22.0%	30.8%
Valid n		16,959			11,603			1,856			1,063	
Worry about Getting Sick from H1N1 Vaccine (HBM: Barrier)												
High Worry	31.0%	29.8%	32.2%	22.2%	21.0%	23.5%	39.0%	35.3%	42.9%	34.9%	29.9%	40.2%
Low Worry	69.0%	67.8%	70.2%	77.8%	76.5%	79.1%	61.0%	57.1%	64.7%	65.1%	59.8%	70.1%
Valid n		17,539			12,023			1,956			1,112	
Effectiveness of H1N1 Vaccine (HBM: Benefit)												
Low Effectiveness	11.5%	10.6%	12.4%	12.9%	11.9%	14.1%	21.7%	18.3%	25.6%	14.6%	11.6%	18.4%
High Effectiveness	88.5%	87.6%	89.4%	87.1%	85.9%	88.2%	78.3%	74.5%	81.8%	85.4%	81.6%	88.4%
Valid n		14,987			10,137			1,634			942	

Note: % and confidence interval (CI) estimates account for the NHFS complex sampling design
Valid *n*=unweighted sample

Nested Logistic Regression Models

In table 3, I present results from logistic regression models that utilize FIML estimation to address missing data. Model 1 shows the odds of H1N1 vaccination were significantly higher among white females than the other three race/sex groups, after accounting for differences in age. I observe a clear relationship between race and gender in vaccination with white and black males reporting 9% and 29% lower odds of vaccination, respectively, than white females. Odds of vaccination for black females were 45% lower than white females. Model 1 also shows lower odds of vaccination among younger individuals compared to those 65 and older – an observation that remains relatively constant throughout all models.

Model 2 builds on the previous model by including measures of socioeconomic status. This model does not find any difference in vaccination odds between those below poverty and those with household incomes in excess of $75,000. Interestingly however, I find that individuals whose household incomes were above the poverty line but below $75,000 have 14% lower odds of vaccination than the most economically disadvantaged, a finding that is not significant at the traditional $p<0.05$ level but approaches minimal criteria for statistical significance ($p<0.1$). As educational attainment increases, vaccination odds also increase. Respondents with a college degree report 71% higher odds of vaccination than those with <12 years of school. In addition, model 2 shows a positive impact of marriage on vaccination (AOR 1.25, $p<.01$). After introducing these SES variables, white males and black females still report lower significantly odds of

vaccination than white females, but the negative effect observed among black males in model 1 no longer appears.

Model 3 introduces measures that indicate whether the respondent is at-risk of H1N1 infection or complications or is in close contact with vulnerable populations. Persons in regular contact with a child <6 months of age have 65% higher odds of H1N1 vaccination than persons without such contact. I observe a similar effect size among those with a self-reported chronic condition compared to those with no reported chronic condition. The odds of vaccination among healthcare workers are 2.7 times higher than persons not employed in a healthcare profession. I find it notable that the inclusion of the risk-status variables attenuates differences between white females and both black and white males. However, the odds of vaccination among black females remain considerably lower than white females (AOR 0.55, $p<.001$).

In model 4, I add healthcare coverage and physician recommendation for the H1N1 vaccine. Those with some form of healthcare coverage had 2.5 times higher odds of vaccination compared to those with no coverage. In addition, the odds of vaccination were nearly *seven times* higher among respondents who received a physician's recommendation. Despite these very strong effects, the substantial disadvantage among black females remains fully intact even when controlling for healthcare-related variables (AOR 0.51, $p<.001$)

Model 5 introduces the HBM measures into the analysis. Perceptions regarding H1N1 vaccine safety and the severity of the H1N1 pandemic are not statistically significant predictors of vaccination. However, perceived personal susceptibility to H1N1

infection (AOR 4.75, $p<.001$) and perceived effectiveness of the H1N1 vaccine (AOR 4.31, $p<.001$) are strong predictors of vaccination. After inclusion of these HBM variables, the influence of marital status, health insurance, close contact with child <6 months of age, being a healthcare worker, and having a chronic condition are somewhat attenuated. It is also notable that the apparent disadvantage experienced by white males in model 1 is reversed in model 4 – with white males reporting 28% higher odds of vaccination when compared to white females ($p<.001$), indicating that these variables may suppress white male vaccination. However, it appears that controlling for a variety of demographic, SES, healthcare and HBM variables does little in accounting for the lower odds of vaccination experienced by black females, whose odds of vaccination remain lower than those of white females consistently through all models.

TABLE 3. Results from Logistic Regression Models of 2009 H1N1 Influenza Vaccination (*n*=33,329)

Characteristics	Model 1			Model 2			Model 3		
	AOR	95% CI		AOR	95% CI		AOR	95% CI	
Race/Sex									
White, Female	1.00			1.00			1.00		
White, Male	0.91*	0.83	0.99	0.88**	0.80	0.96	0.98	0.89	1.08
Black, Male	0.71**	0. 55	0.92	0.80	0.62	1.04	0.90	0.70	1.18
Black, Female	0.55***	0.44	0.67	0.62***	0.50	0.76	0.55***	0.44	0.68
Age									
65+				1.00			1.00		
35-64	0.85**	0.77	0.93	0.74***	0.67	0.82	0.71***	0.64	0.78
18-34	0.76***	0.67	0.87	0.77***	0.67	0.87	0.73***	0.63	0.83
Poverty Status									
Below Poverty				1.00			1.00		
<=$75,000, above poverty				0.86†	0.71	1.03	0.85	0.71	1.02
>$75,000				1.05	0.85	1.28	1.03	0.84	1.26
Education									
<12 Years				1.00			1.00		
12 Years				1.27*	1.04	1.55	1.26*	1.03	1.56
Some College				1.24*	1.02	1.52	1.15	0.94	1.42
College Graduate				1.71***	1.40	2.08	1.67***	1.36	2.05
Marital Status									
Not Married				1.00			1.00		
Married				1.25***	1.13	1.38	1.25***	1.13	1.38
Close Contact Child <6 months									
No							1.00		
Yes							1.65***	1.40	1.94
Healthcare Worker									
No							1.00		
Yes							2.70***	2.38	3.07
Chronic Condition									
No							1.00		
Yes							1.65***	1.49	1.82
Health Insurance Status									
No									
Yes									
Dr. Recommendation									
No									
Yes									
Concern about H1N1 (HBM: Severity)									
Low Concern									
High Concern									
Risk of H1N1 Infection (HBM: Susceptibility)									
Low Risk									
High Risk									
Worry about Vaccine (HBM: Barrier)									
High Worry									
Low Worry									
Effectiveness of Vaccine (HBM: Benefit)									
Low Effectiveness									
High Effectiveness									

Note: Adjusted Odds Ratio (AOR) and Confidence Interval (CI) calculated using FIML estimation (Mplus)
† p <0.1; *p <0.05; **p <0.01; ***p <0.001

TABLE 3 (continued). Results from Logistic Regression Models of 2009 H1N1 Influenza Vaccination, (*n*=33,329)

Characteristics	Model 4			Model 5		
	AOR	95% CI		AOR	95% CI	
Race/Sex						
White, Female	1.00			1.00		
White, Male	1.08	0.97	1.19	1.28***	1.15	1.43
Black, Male	0.98	0.74	1.29	0.98	0.72	1.32
Black, Female	0.51***	0.40	0.64	0.57***	0.45	0.73
Age						
65+	1.00			1.00		
35-64	0.76***	0.68	0.85	0.67***	0.59	0.75
18-34	0.76***	0.66	0.88	0.67***	0.57	0.79
Poverty Status						
Below Poverty	1.00			1.00		
<=$75,000, above poverty	0.87	0.72	1.06	0.95	0.76	1.17
>$75,000	1.00	0.81	1.24	1.06	0.84	1.34
Education						
<12 Years	1.00			1.00		
12 Years	1.15	0.92	1.43	1.14	0.89	1.46
Some College	1.02	0.82	1.27	1.13	0.88	1.45
College Graduate	1.45**	1.16	1.80	1.61***	1.25	2.06
Marital Status						
Not Married	1.00			1.00		
Married	1.14	1.01	1.27	1.15*	1.01	1.30
Close Contact Child <6 months						
No	1.00			1.00		
Yes	1.37***	1.16	1.62	1.28*	1.05	1.54
Healthcare Worker						
No	1.00			1.00		
Yes	2.50***	2.18	2.86	2.13***	1.84	2.47
Chronic Condition						
No	1.00			1.00		
Yes	1.31***	1.18	1.45	1.14*	1.02	1.29
Health Insurance Status						
No	1.00			1.00		
Yes	2.11***	1.71	2.60	2.04***	1.63	2.55
Dr. Recommendation						
No	1.00			1.00		
Yes	6.68***	6.02	7.41	5.51***	4.92	6.17
Concern about H1N1 (HBM: Severity)						
Low Concern				1.00		
High Concern				1.11	0.99	1.24
Risk of H1N1 Infection (HBM: Susceptibility)						
Low Risk				1.00		
High Risk				4.75***	4.21	5.37
Worry about Vaccine (HBM: Barrier)						
High Worry				1.00		
Low Worry				0.94	0.83	1.06
Effectiveness of Vaccine (HBM: Benefit)						
Low Effectiveness				1.00		
High Effectiveness				4.31***	3.30	5.62

Note: Adjusted Odds Ratio (AOR) and Confidence Interval (CI) calculated using FIML estimation (Mplus)
† p <0.1; *p <0.05; **p <0.01; ***p <0.001

DISCUSSION

My analysis shows considerable variation in the odds of H1N1 vaccination by race and gender. In the age-adjusted model, I observe an advantage among white females in obtaining vaccinations over white males, black males, and black females. However, controlling for SES variables that could mediate the association between race/sex and vaccination, such as poverty status and education, substantially reduces the disparity in odds ratios between black males and white females. Furthermore, when controlling for SES, health beliefs, and healthcare access and contact, white males have significantly *higher* odds of vaccination than white females.

What is especially troubling though is the little or no change in odds of vaccination for black females across models. Even when controlling for demographic variables, socioeconomic status, chronic conditions, healthcare status, and perceptions of H1N1, black females consistently report significantly lower odds of vaccination than white females. This finding is unexpected; I had supposed that inclusion of the HBM constructs would help explain disparate odds of vaccination between white and black females. I therefore urge additional research into understanding the health behaviors of black women, especially with regard to health interventions such as flu vaccinations. I believe this recommendation is warranted to prevent the possibility for a disproportionate disease burden in this population during a future influenza outbreak.

However, it is interesting to note that when controlling for SES-related factors, such as poverty status and education, the disparity in odds ratios between black males and white females appears to attenuate. Addressing substantial disparities in educational

attainment and poverty status observed between black males and white females could result in better vaccination outcomes among black males. The ability of SES-related characteristics to lower vaccination rates among black males, but not among black females, also suggests that these social determinants of health operate differently among women than men. As further evidence for differing impacts of gender and race on vaccination outcomes, my models show that white males experience statistically higher odds of vaccination compared to white females when controlling for SES, health beliefs, and healthcare access.

Factors such as education and especially health insurance may have a positive role in increasing vaccination uptake. A recent report from the CDC estimates that healthcare non-coverage rates for blacks in 2017 is 9.8% (Clarke, Schiller and Norris 2017). This updated CDC estimate is considerably lower than the 24.1% healthcare non-coverage rates for blacks I estimate using the NHFS, which was administered from 2009-2010. It is likely this current improvement, if sustained, in health care coverage among blacks will have a meaningful impact on vaccination in the event of a future influenza pandemic.

Both whites and blacks report similar levels of belief regarding the risk of H1N1 infection, the effectiveness of the H1N1 vaccine, and similar levels of receiving recommendations from their doctors to vaccinate. Paradoxically, while a lower proportion of blacks were vaccinated against H1N1, this group felt a higher general concern about the pandemic. However, logistic regression analysis showed that concern about possible adverse reactions to the vaccine is an insignificant predictor of vaccination when controlling for other factors.

Among the HBM measures, it appears that *perceived susceptibility* and *perceived benefit* were most powerful in predicting vaccination. Differing beliefs in the other HBM measures such as *perceived severity* and *perceived barriers* did not produce significant changes in the odds of vaccination after controlling for other factors. The apparent lack of influence that worries about the severity of H1N1 have on vaccination decisions may be because my analysis only includes respondents interviewed from January 2010 through June 2010, which is after the initial outbreak of the 2009 H1N1 virus. It is possible that perceived severity would increase the closer one is to the initial outbreak and might be more influential in the decision to vaccinate.

While a strength of my analysis is the inclusion of attitudinal measures related to H1N1 influenza and vaccination, it is simultaneously a limitation. The items used to describe each of the four main components of the HBM provide valuable insight into beliefs that predict health behavior, but may not reflect all aspects of perceived severity, susceptibility, barriers, and benefits. While previous studies incorporating the HBM in analyzing H1N1 vaccination behavior include more intricate measures of HBM components than are available in the NHFS, these studies often rely on localized samples preventing generalizations to the broader U.S. adult population. An advantage of my study, which uses a nationally representative sample of U.S. adults, is its ability to make broader generalizations about the association between HBM factors and vaccination. Including attitudinal measures in large public health surveys, such as the National Health Interview Survey (NHIS) and Behavioral Risk Factor Surveillance System (BRFSS)

would further aid researchers in understanding the social and psychological determinants of vaccination.

CONCLUSION

By utilizing the National H1N1 Flu Survey, which is representative of US non-institutionalized adults, I was able to analyze predictors of vaccination behavior by race and gender while considering the influence of both structural and attitudinal barriers to vaccination. This permitted my analysis to contribute to the H1N1 vaccination literature by considering the influence of other factors not usually measured in the standard U.S. government health surveys such at the National Health Interview Survey. By including measures of perceived severity, perceived susceptibility, perceived barriers, and perceived benefits regarding the 2009 pandemic and vaccine, I contribute to the literature regarding H1N1 vaccination, which tends to focus particularly on socioeconomic predictors of vaccination.

While descriptive statistics indicate blacks were vaccinated at lower levels than whites, the regression analyses illustrate the importance of viewing the intersectionality of race and gender in predicting vaccination behavior. The intersection of race and gender at the micro level does appear to influence health behaviors through other mediating variables. For example, when controlling for vast socioeconomic disparities, black males appear to have similar odds of vaccination as white females. In addition, if white males possessed the same beliefs as white females regarding H1N1 risks and the vaccine, they would actually enjoy an advantage in obtaining vaccinations over white females. An

alarming finding though is the low odds of vaccination for black females, when compared to white females, despite controlling for SES, health status, and perceptions about the H1N1 epidemic and vaccine. Future research should grapple further with this persistent disparity to prevent a disproportionate burden of disease among black females during the next outbreak of a novel influenza strain.

REFERENCES

Armstrong, Katrina, Michelle Berlin, J. Sanford Schwartz, Kathleen Propert, and Peter A. Ubel. 2001. "Barriers to Influenza immunization in a low-income urban population." *American Journal of Preventive Medicine* 20(1):21-25.

Bauer, Greta R. 2014. "Incorporating Intersectionality Theory into Population Health Research Methodology: Challenges and the Potential to Advance Health Equity." *Social Science & Medicine (1982)* 110:10.

Bowleg, Lisa. 2012. "The Problem with the Phrase Women and Minorities: Intersectionality—an Important Theoretical Framework for Public Health." *American Journal of Public Health* 102(7):1267-73.

Braveman, P.A., C. Cubbin, S. Egerter, S. Chideya, K.S. Marchi, M. Metzler, and S. Posner. 2005. "Socioeconomic Status in Health Research." *JAMA: The Journal of the American Medical Association* 294(22):2879.

Braveman, Paula A., Catherine Cubbin, Susan Egerter, David R. Williams, and Elsie Pamuk. 2010. "Socioeconomic Disparities in Health in the United States: What the Patterns Tell Us." *American Journal of Public Health* 100(S1):S186-S96.

Burger, Andrew E., and Eric N. Reither. 2014. "Monitoring Receipt of Seasonal Influenza Vaccines with BRFSS and NHIS Data: Challenges and Solutions." *Vaccine* 32(31):3950-54.

Burger, Andrew E., Eric N. Reither, Erin Trouth Hofmann, and Svenn-Erik Mamelund. 2017. "The Influence of Hispanic Ethnicity and Nativity Status on 2009 H1N1 Pandemic Vaccination Uptake in the United States." *Journal of Immigrant and Minority Health*:1-8.

Centers for Disease Control and Prevention. 2009a. "Questions and answers on 2009 H1N1 vaccine financing." (https://www.cdc.gov/H1N1flu/vaccination/statelocal/vaccine_financing.htm).

Centers for Disease Control and Prevention. 2009b. "Use of influenza A (H1N1) 2009 monovalent vaccine: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2009." *Morbidity and Mortality Weekly Report: Recommendations and reports*:1-7.

Centers for Disease Control and Prevention. 2010. "The 2009 H1N1 Pandemic: Summary Highlights, April 2009-April 2010." (https://www.cdc.gov/h1n1flu/cdcresponse.htm).

Centers for Disease Control and Prevention. 2011. "Final estimates for 2009-10 seasonal influenza and influenza A(H1N1) 2009 monovalent vaccination coverage - United States, August 2009 through May, 2010." (https://www.cdc.gov/flu/fluvaxview/coverage_0910estimates.htm).

Champion, Victoria L., and Celette S. Skinner. 2008. "The Health Belief Model." Pp. 45-65 in *Health Behavior and Health Dducation: Theory, Research, and Practice*, edited by Glanz K, RImer BK & Viswanath K. San Francisco, CA: Jossey-Bass

Clarke, Tainya C., Jeannine S. Schiller, and Tina Norris. 2017. "Early Release of Selected Estimates Based on Data from the January–June 2017 National Health Interview Survey." (https://www.cdc.gov/nchs/data/nhis/earlyrelease/earlyrelease201712.pdf).

Coe, Antoinette B., Sharon B.S. Gatewood, and Leticia R. Moczygemba. 2012. "The Use of the Health Belief Model to Assess Predictors of Intent to Receive the Novel (2009) H1N1 Influenza Vaccine." *Innovations in Pharmacy* 3(2):1.

Dee, Deborah L, Diana M Bensyl, Jacqueline Gindler, Benedict I Truman, Barbara G Allen, Tiffany D'Mello, Alejandro Pérez, Laurie Kamimoto, Matthew Biggerstaff, and Lenee Blanton. 2011. "Racial and Ethnic Disparities in Hospitalizations and Deaths Associated with 2009 Pandemic Influenza A (H1N1) Virus Infections in the United States." *Annals of Epidemiology* 21(8):623-30.

DeNavas-Walt, Carmen, B. D. Proctor, and J. C. Smith. 2011. "Income, Poverty, and Health Insurance Coverage in the United States: 2010." Washington, DC: U.S. Census Bureau. (https://www.census.gov/prod/2011pubs/p60-239.pdf).

Dong, Yiran, and Chao-Ying Joanne Peng. 2013. "Principled Missing Data Methods for Researchers." *SpringerPlus* 2:222.

Freid, Virginia M., Amy B. Bernstein, and Mary Ann Bush. 2012. "Multiple Chronic Conditions among Adults Aged 45 and Over: Trends Over the Past 10 Years." *Women* 45:64.

Frew, Paula M., Julia E. Painter, Brooke Hixson, Carolyn Kulb, Kathryn Moore, Carlos del Rio, Alejandra Esteves-Jaramillo, and Saad B. Omer. 2012. "Factors

Mediating Seasonal and Influenza A (H1N1) Vaccine Acceptance among Ethnically Diverse Populations in the Urban South." *Vaccine* 30(28):4200-08.

Galarce, Ezequiel M, Sara Minsky, and K Viswanath. 2011. "Socioeconomic Status, Demographics, Beliefs and A (H1N1) Vaccine Uptake in the United States." *Vaccine* 29(32):5284-89.

Gargano, Lisa M., Julia E. Painter, Jessica M. Sales, Christopher Morfaw, LaDawna M. Jones, Dennis, Murray, Gina M. Wingood, Ralph J. DiClemente, and James M. Hughes. 2011. "Seasonal and 2009 H1N1 Influenza Vaccine Uptake, Predictors of Vaccination and Self-Reported Barriers to Vaccination among Secondary School Teachers and Staff." *Human Vaccines* 7(1):89.

Hankivsky, Olena. 2012. "Women's Health, Men's health, and Gender and Health: Implications of Intersectionality." *Social Science & Medicine* 74(11):1712-20.

Kim, Jin E., and Nolan Zane. 2016. "Help-Seeking Intentions among Asian American and White American Students in Psychological Distress: Application of the Health Belief Model." *Cultural Diversity and Ethnic Minority Psychology* 22(3):311.

Klein, Sabra L., Catherine Passaretti, Martha Anker, Peju Olukoya, and Andrew Pekosz. 2010. "The Impact of Sex, Gender and Pregnancy on 2009 H1N1 Disease." *Biology of Sex Differences* 1(1):5.

Krieger, Nancy, Diane L. Rowley, Allen A. Herman, and Byllye Avery. 1993. "Racism, Sexism, and Social Class: Implications for Studies of Health, Disease, and Well-Being." *American Journal of Preventive Medicine* 9(6 Suppl):82-122.

Kumar, Supriya, Sandra Crouse Quinn, Kevin H. Kim, Donald Musa, Karen M. Hilyard, and Vicki S. Freimuth. 2012. "The Social Ecological Model as a Framework for Determinants of 2009 H1N1 Influenza Vaccine Uptake in the United States." *Health Education & Behavior* 39(2):229-43.

Link, Bruce G., and Jo Phelan. 1995. "Social conditions as fundamental causes of disease." *Journal of Health and Social Behavior* (Extra Issue):80-94.

Livi, Stefano, Fabrizio Zeri, and Rossella Baroni. 2017. "Health beliefs affect the correct replacement of daily disposable contact lenses: Predicting compliance with the Health Belief Model and the Theory of Planned Behaviour." *Contact Lens and Anterior Eye* 40(1):25-32.

Mamelund, Svenn-Erik. 2011. "Geography May Explain Adult Mortality from the 1918–20 Influenza Pandemic." *Epidemics* 3(1):46-60.

Morton, Patricia M, and Kenneth F Ferraro. 2014. "Race and Health Disparities." *The Wiley Blackwell Encyclopedia of Health, Illness, Behavior, and Society*.

Muthén, Linda K., and Bengt O. Muthén. 2017. *Mplus User's Guide: Eighth Edition*. Los Angeles, CA: Muthén & Muthén.

Organization, World Health. 2010. "Sex, Gender and Influenza."

Osterholm, Michael T., Nicholas S. Kelley, Alfred Sommer, and Edward A. Belongia. 2012. "Efficacy and Effectiveness of Influenza Vaccines: A Systematic Review and Meta-Analysis." *The Lancet Infectious Diseases* 12(1):36-44.

Quinn, Sandra Crouse, Supriya Kumar, Vicki S. Freimuth, Donald Musa, Nestor Casteneda-Angarita, and Kelley Kidwell. 2011. "Racial Disparities in Exposure, Susceptibility, and Access to Health Care in the US H1N1 Influenza Pandemic." *American Journal of Public Health* 101(2):285.

Russell, Charles J, and Robert G Webster. 2005. "The Genesis of a Pandemic Influenza Virus." *Cell* 123(3):368-71.

Shrestha, Sundar S., David L. Swerdlow, Rebekah H. Borse, Vimalanand S. Prabhu, Lyn Finelli, Charisma Y. Atkins, Kwame Owusu-Edusei, Beth Bell, Paul S. Mead, and Matthew Biggerstaff. 2011. "Estimating the Burden of 2009 Pandemic Influenza A (H1N1) in the United States (April 2009–April 2010)." *Clinical Infectious Diseases* 52:S75-S82.

Siordia, Carlos. 2015. "Disability Prevalence According to a Class, Race, and Sex (CSR) Hypothesis." *Journal of Racial and Ethnic Health Disparities* 2(3):303-10.

StataCorp, LP. 2017. "Stata 15." StataCorp LP., College Station, Texas, United States. http://www.stata.com.

Statistics, National Center for Health. 2011. "Vital Statistics Reports, Volume 60, Number 1, Births: Final Data for 2009."

Statistics, U.S. Department of Labor. 2010. "Labor Force Characteristics by Race and Ethnicity, 2009."

Strecher, Victor J., Victoria L. Champion, and Irwin M. Rosenstock. 1997. "The Health Belief Model and Health Behavior." Pp. 71-91 in *Handbook of Health Behavior Research*, edited by David S. Gochman. New York, NY: Plenum Press.

Thompson, Deborah L., Jessica Jungk, Emily Hancock, Chad Smelser, Michael Landen, Megin Nichols, David Selvage, Joan Baumbach, and Mack Sewell. 2011. "Risk Factors for 2009 Pandemic Influenza A (H1N1)-Related Hospitalization and Death among Racial/Ethnic Groups in New Mexico." *American Journal of Public Health* 101(9):1776-84.

United States Government Accountability Office. 2011. "Influenza Pandemic: Lessons from the H1N1 Pandemic Should be Incorporated into Future Planning." (https://www.gao.gov/products/GAO-11-632).

Uscher-Pines, Lori, Jurgen Maurer, and Katherine Harris. 2011. Uscher-Pines, Lori, Jurgen Maurer, and Katherine Harris. 2011. "Racial and Ethnic Disparities in Uptake and Location of Vaccination for 2009-H1N1 and Seasonal Influenza." *American Journal of Public Health*. 101(7):1252-1255.

Vlahov, David, Keosha T. Bond, Kandice C. Jones, and Danielle C. Ompad. 2012. "Factors Associated with Differential Uptake of Seasonal Influenza Immunizations among Underserved Communities during the 2009–2010 Influenza Season." *Journal of Community Health* 37(2):282-87.

PAPER 3

IMPACT OF RACE/ETHNICITY AND GENDER ON 2009 H1N1 VACCINATION: A STRUCTURAL EQUATION MODELING APPROACH

ABSTRACT

Background: Previous studies have observed racial and ethnic disparities in vaccination uptake during the 2009 H1N1 pandemic. The purpose of this study is to estimate the influence of race/ethnicity and gender on H1N1 vaccinations while considering both structural barriers and H1N1 related beliefs.

Methods: Using data from the National H1N1 Flu Survey, I examine vaccination disparities among non-Hispanic whites, non-Hispanic blacks, and Hispanics while considering the intersectionality of gender. In addition to providing descriptive statistics on vaccination uptake for race-gender groups, I estimate the extent to which socioeconomic status and health beliefs account for disparities in H1N1 vaccination through a series of structural equation models.

Results: My analysis indicates that H1N1 vaccination rates vary by race/ethnicity and gender during the 2009 H1N1 pandemic. White females and males were most likely to receive the vaccine (28.4% and 26.6% respectively). Even after accounting for socioeconomic status and health beliefs, I find black females and Hispanic males report significantly lower odds of vaccination than white females.

Discussion: My analysis contributes to the body of research regarding H1N1 vaccination behaviors by incorporating both socioeconomic and attitudinal concepts as potential mediators of racial/ethnic and gender vaccination behaviors within a structural equation model framework. The results indicate both black females and Hispanic males experience lower odds of vaccination even when considering potential SES and belief mediators. I suggest the U.S. government consider race/ethnicity and gender as important predictors of vaccination for future influenza pandemics.

BACKGROUND

In 2011, the Centers for Disease Control and Prevention (CDC) published its final report on H1N1 vaccination uptake. This report provides important vaccination statistics for the general population and those populations recommended by the CDC and Advisory Committee on Immunization Practices (ACIP) to receive the H1N1 vaccination (CDC 2011). However, the report does not disaggregate by important sociodemographic characteristics such as race/ethnicity or gender. Subsequent studies on the 2009 H1N1 pandemic confirm that gender, racial, and ethnic disparities in vaccination existed (Santibanez et al. 2013; Uscher-Pines, Maurer and Harris 2011). Both structural barriers, such as lack of insurance and low socioeconomic status (SES), and perceptions about the H1N1 pandemic and vaccine are known to be predictive of vaccination (Burger et al. 2017; Galarce, Minsky and Viswanath 2011; Gargano et al. 2011; Kumar et al. 2012). Utilizing concepts from the Health Belief Model (HBM) and Fundamental Cause Theory (FCT), I examine the relationship that structural barriers and health beliefs may have with H1N1 vaccination behaviors. I also estimate the extent to which social structures and health beliefs account for disparities in H1N1 vaccination among men and women in different racial/ethnic groups.

The Health Belief Model

The Health Belief Model (HBM) is a commonly used and well recognized theoretical explanation for health behaviors across a wide variety of conditions, including everything from predicting skin cancer protective behavior (Carmel, Shani and

Rosenberg 1994) to promoting healthy eating habits among college students (Deshpande, Basil and Basil 2009). Originally developed in the 1950s by a group of social psychologists within the U.S. Public Health Service as a general framework to explain why individuals access and use preventive health services, the model relies heavily on the cognitive theories of psychology. The HBM predicts health behavior by the simultaneous effects of perceived susceptibility, severity, benefits, and barriers to illness and subsequent health interventions. The core theoretical concepts of the HBM (collectively and not individually) have become important factors in predicting health behavior such as vaccinations (Rosenstock, Strecher and Becker 1988).

Fundamental Cause Theory

Developed in the 1990's, Fundamental Cause Theory (FCT) encourages an examination of health disparities through distal, rather than proximate, causes of disease. By focusing on broader societal disparities in resources, FCT suggests that public health initiatives targeted at only proximate causes of disease are not particularly effective at addressing population health because they lack the ability to change the structural, "fundamental" causes of health disparities (Phelan and Link 2005). General influenza vaccination promotion campaigns, such as those seen during the 2009 H1N1 pandemic (Ma et al. 2006), may prove insufficient in overcoming deeply rooted distal determinants of health. With respect to H1N1 vaccination, this means that individuals with adequate resources are most likely to "convert" these public health messages into the necessary action—seeking and obtaining the vaccine.

Even when health resources are readily available, individuals must be able to access those resources in order for the intervention to be successful (Link and Phelan 1995). Through the use of *flexible resources*, which Link and Phelan (1995) describe as "money, knowledge, power, prestige, and the kinds of interpersonal resources embodied in the concepts of social support and social network", individuals purposely seek better health outcomes by securing access to health resources (81). Disparities in flexible resources therefore accompany health disparities, such as H1N1 vaccination disparities.

The Intersectionality of Race/Ethnicity and Gender

While substantial evidence supports the existence of racial and ethnic disparities in health and health behaviors (Major, Dovidio and Link 2017), the influence of gender on health is often underreported – despite evidence suggesting significant differences in disease burden by gender during the H1N1 pandemic (Klein et al. 2010). Rather than view race/ethnicity and gender as separate characteristics influencing health, I draw on intersectionality theory and treat gender and race/ethnicity as key components of social identity that are not separable (Bauer 2014; Hankivsky 2012; Shields 2008).

The purpose of this study is to provide a better understanding of racial/ethnic and gender disparities in H1N1 vaccination uptake through structural barriers and H1N1 related beliefs. Figure 1 presents my hypothesized model, which illustrates how beliefs and barriers may act as *mediators* between race/ethnicity and gender and the H1N1 vaccine. According to the HBM, perceptions regarding the risk and severity of H1N1 infection and beliefs about the effectiveness and safety of the H1N1 vaccine should be associated with vaccination behavior. Considering past and present discrimination by the

medical community, lower levels of confidence in medicine are often observed among racial minorities (Boulware et al. 2003; Clayman et al. 2010). In addition, FCT posits that sociodemographic characteristics may be predictive of vaccination because they are associated with flexible resources, which vary considerably across groups defined by gender and race/ethnicity (Morton and Ferraro 2014). Using data available from the 2009 National H1N1 Flu Survey (NHFS), I estimate the influence race/ethnicity and gender may have on vaccination uptake directly and indirectly through potential mediators that reflect key concepts in the HBM and FCT theories. My study focuses on men and women in three major racial/ethnic groups: non-Hispanic whites (hereafter referred to as whites), non-Hispanic blacks (hereafter referred to as blacks), and Hispanics.

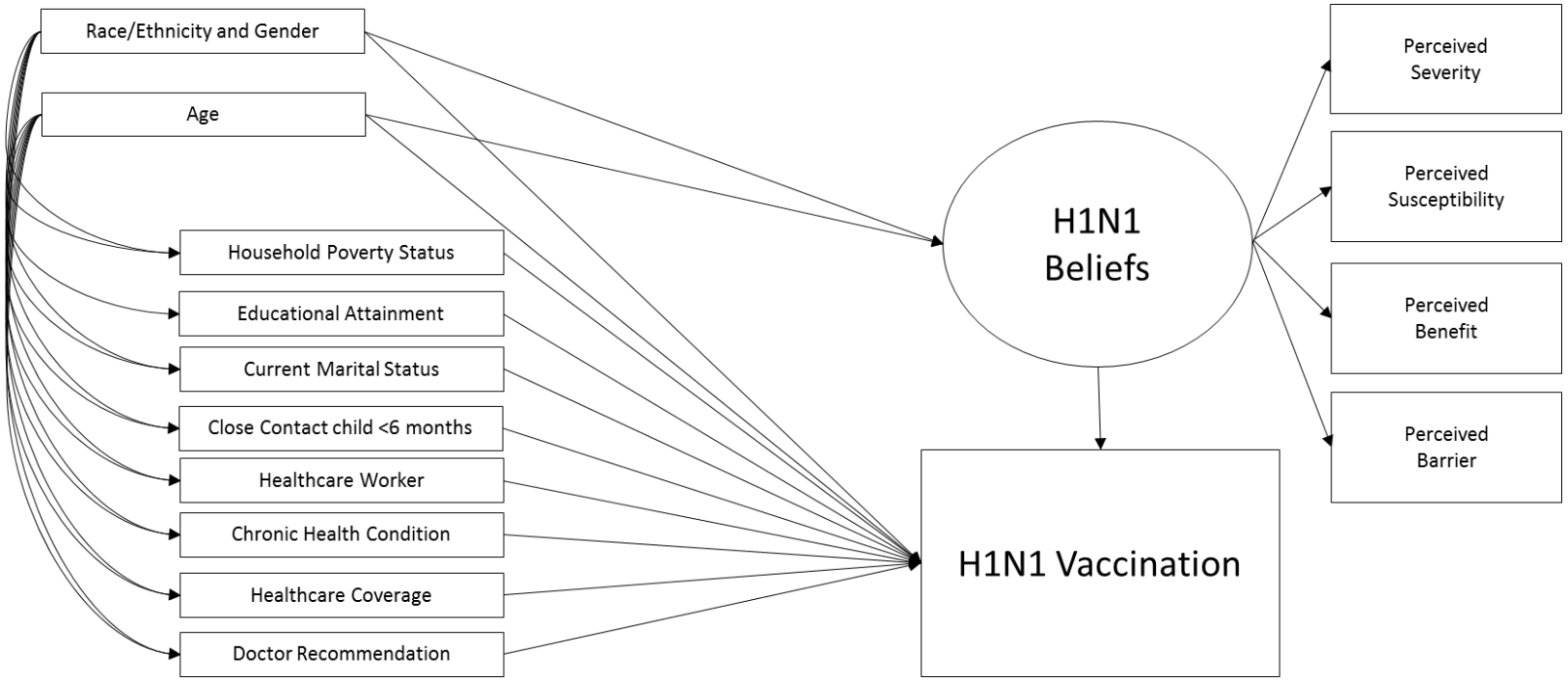


Figure 1. Conceptual diagram for the final SEM model estimating the effects of race/ethnicity, gender, and sociodemographic, health beliefs, health status, and healthcare status characteristics on H1N1 vaccination. Latent constructs are shown in ellipses and observed variables are shown in rectangles.

METHODS

Data

For the analysis, I will use the National H1N1 Flu Survey (NHFS). Various U.S. federal health agencies administered the NHFS in the interest of gathering representative data of H1N1 vaccination behaviors and beliefs in the U.S. adult population. The NHFS represents a unique and rich source of data in understanding vaccination behaviors and beliefs during the pandemic. Unique among large U.S. public health datasets, the NHFS measured perceptions about the severity of the H1N1 pandemic and the effectiveness and safety of the vaccine.

During the early stages of the pandemic, vaccination shortages prompted the CDC to recommend vaccination for certain at-risk groups. While the shortages were temporary, many individuals may not have felt eligible for vaccination during the early stages of the pandemic. In order to reduce the possibility of false negatives (individuals who eventually received the vaccine but had not yet been vaccinated when the survey was completed) in my calculations, I limit the analysis to those interviewed from January 2010 through June 2010. A similar approach is shown to significantly reduce error due to false negatives in seasonal influenza vaccination estimates (Burger and Reither 2014).

Dependent Variable

The dependent variable, H1N1 vaccination, is self-reported by the respondent. I should note that the H1N1 vaccine was available via both a nasal spray and intradermal

injection. As I am less interested in the mode of vaccine, I consider individuals vaccinated via either spray or injection as vaccinated.

Exogenous Independent Variables

Race/Ethnicity and Gender. The NHFS provides self-reported measures of respondent racial and ethnic identifies in addition to gender. I use these self-reported measures to create six mutually exclusive race/gender categories including: white female, white male, black female, black male, Hispanic female, and Hispanic male.

Potential Mediating Variables

H1N1 Beliefs. The NHFS includes several items that parallel important HBM theoretical constructs. Due to limitations of variable availability, I am limited to single variables representing each of the core HBM concepts used to create a latent variable that I call H1N1 Beliefs. The NHFS includes questions asking respondents how concerned they are about H1N1 (*perceived severity*), what their perceived personal risk is of becoming sick from H1N1 (*perceived susceptibility*), how worried they are about getting sick from the H1N1 vaccination (*perceived barriers*), and how effective they believe the H1N1 vaccination is in preventing disease (*perceived benefits*). The NHFS records responses to these HBM questions using a four-point, balanced, Likert-type scale (see table 3 & table 4).

Flexible Resources. Important SES-related characteristics are included in the NHFS that I recode into dichotomous measures to ease the interpretation of the SEM analysis. I include measures of household poverty status (0=not in poverty, 1=in poverty),

educational attainment (0=Less than a Bachelor's degree, 1=Bachelor's degree or higher), and marital status (0=not currently married, 1= currently married). These variables are included in the analysis as potential mediators of race/gender effects on H1N1 vaccination.

Target Populations. In addition to HBM and FCT related variables, I include dichotomous measures of whether the individual belonged to a group that the CDC urged to receive an H1N1 vaccination. These groups include individuals in daily close contact of children <6 months of age, healthcare workers, and those with certain chronic conditions.

Healthcare Status. As additional potential mediators between race/gender and H1N1 vaccination, I include healthcare coverage (0=not covered, 1=covered) and whether the respondent received a recommendation from their healthcare provider to vaccinate (0=no recommendation received, 1=recommendation received).

Analysis

First, I use Stata 15 (StataCorp 2017) to estimate descriptive statistics and associated measures of statistical uncertainty. I use Stata procedures designed to account for complex sampling designs, like those of the NHFS. Second, I use Mplus 8 (Muthén and Muthén 2017) to estimate a latent measurement model of H1N1 Beliefs using confirmatory factor analysis (CFA). In estimating the initial measurement model, I chose to use the weighted least square mean and variance adjusted estimator (WLSMV), which is designed for categorical variable analysis and provides traditional measures of model-

fit. Third, I employ structural equation modeling (SEM) to estimate the influence of race/ethnicity and gender on vaccination while including potential FCT and HBM related mediators. By comparing model-fit statistics between models, I will provide rudimentary estimates of model fit.

Due to missing data issues within the NHFS, I opted to run the SEM analyses with maximum likelihood estimation with robust standard errors (MLR) using full-information maximum likelihood (FIML) estimation instead of the more properly designed WLSMV estimator for ordinal variables (Yuan and Bentler 2000). MLR is a preferred alternative in my data analysis as it is better suited to provide parameter estimates with standard errors that are robust to data non-normality, a condition that exists in these data. Variables used to create the HBM latent construct are ordinal-level measures, with some exhibiting a strong floor or ceiling effect (majority of cases on one side of ordinal scale) – a condition that MLR is designed to accommodate.

By choosing the FIML option in MLR, I am able to estimate models that address problematic missingness and non-normality issues in the data. The tradeoff is that I am unable to produce traditional fit statistics such as CFI, TLI, RMSEA, or SRMR. In order to compare fit across models, I use Bayesian Information Criterion (BIC) statistics. For ease of interpretation, at times, I discuss regression coefficients as odds ratios with 95% confidence intervals; I obtain these estimates and appropriate 95% CIs using Mplus 8.

RESULTS

Descriptive Statistics of Sociodemographic Characteristics.

Table 1 and table 2 present descriptive statistics across racial groups by male/female gender categories. In viewing information across both tables, I observe that a higher proportion of white females (28.4%) and white males (26.3%) received the H1N1 vaccine than black or Hispanic males and females. Black females and Hispanic males reported the lowest vaccination percentages, at 17.5% and 19.1% respectively.

With regard to measures of socioeconomic status, I observe substantial differences in the poverty status of households across racial/ethnic groups. The percentage of households in poverty for whites (approximately 8.4% when averaged across males and females) is considerably lower than the prevalence of poverty in black (29.4%) or Hispanics (36.6%) households. In addition, I find significant educational differences between groups, with 46.3% and 41.2% of white males and females reporting a college degree or higher, percentages that are nearly double that of blacks and Hispanics.

The percentage belonging to a CDC “high priority” population varies by race/ethnicity and gender. A greater percentage of Hispanics (both male and female) reported being in daily close contact with a child <6 months of age. Whereas approximately 1 in 4 white (regardless of gender) and black male respondents reported a chronic condition, 1 in 3 black females reported a chronic condition. Hispanics, both male and female, were less likely than other groups to report a chronic condition (23.1%

of Hispanic females and only 13.0% of Hispanic males). Black females were most likely to report healthcare worker (22.5%) as a profession in the NHFS.

Healthcare coverage varies considerably by race/ethnicity and gender. Both white females and males report high levels of healthcare coverage (90.5% and 88.1%), with black females and males (79.7% and 71.0%), and Hispanic females and males (63.1% and 52.2%) reporting considerably lower levels of coverage. Nevertheless, the percentages reporting a doctor's recommendation to receive the H1N1 vaccine are similar across racial categories, with a higher proportion of females receiving such recommendations than males.

TABLE 1. Descriptive Statistics of Sociodemographic and Other Control Variables among White, Black, and Hispanic Female Respondents in the National H1N1 Flu Survey (NHFS)

Characteristics	White Female			Black Female			Hispanic Female		
	%	95% CI -/+		%	95% CI -/+		%	95% CI -/+	
H1N1 Vaccination									
No	71.6%	70.5%	72.8%	82.5%	79.4%	85.2%	77.3%	73.1%	80.9%
Yes	28.4%	27.2%	29.5%	17.5%	14.8%	20.6%	22.7%	19.1%	26.9%
Valid n		*17,846*			*1,997*			*1,358*	
Age									
<64	78.6%	77.7%	79.5%	84.4%	81.7%	86.7%	92.2%	89.9%	94.0%
65+	21.4%	20.5%	22.3%	15.6%	13.3%	18.3%	7.8%	6.0%	10.1%
Valid n		*17,907*			*2,013*			*1,366*	
Household Poverty									
Not in Poverty	89.9%	89.1%	90.8%	67.7%	63.7%	71.6%	58.4%	52.8%	63.7%
In Poverty	10.1%	9.2%	10.9%	32.3%	28.4%	36.3%	41.6%	36.3%	47.2%
Valid n		*14,885*			*1,623*			*1,119*	
Education									
Less than a BA/BS	58.8%	57.5%	60.0%	75.7%	72.4%	78.6%	81.4%	77.6%	84.6%
BA/BS or more	41.2%	40.0%	42.5%	24.3%	21.4%	27.6%	18.6%	15.4%	22.4%
Valid n		*17,078*			*1,895*			*1,288*	
Marital Status									
Not Married	41.6%	40.3%	42.9%	71.7%	68.1%	75.0%	48.2%	43.3%	53.1%
Married	58.4%	57.1%	59.7%	28.3%	25.0%	31.9%	51.8%	46.9%	56.7%
Valid n		*17,036*			*1,882*			*1,283*	
Close Contact with child <6 months									
No	90.5%	89.7%	91.3%	88.3%	85.4%	90.7%	86.2%	82.4%	89.3%
Yes	9.5%	8.7%	10.3%	11.7%	9.3%	14.6%	13.8%	10.7%	17.6%
Valid n		*17,355*			*1,934*			*1,343*	
Healthcare Worker									
No	82.1%	81.0%	83.1%	77.5%	73.7%	80.9%	86.2%	81.9%	89.6%
Yes	17.9%	16.9%	19.0%	22.5%	19.1%	26.3%	13.8%	10.4%	18.1%
Valid n		*17,331*			*1,932*			*1,341*	
Chronic Condition									
No	71.4%	70.2%	72.5%	66.5%	62.7%	70.2%	76.9%	72.7%	80.7%
Yes	28.6%	27.5%	29.8%	33.5%	29.8%	37.3%	23.1%	19.3%	27.3%
Valid n		*17,248*			*1,914*			*1,340*	
Healthcare Coverage									
No	9.5%	8.6%	10.5%	20.3%	16.5%	24.7%	36.9%	31.7%	42.5%
Yes	90.5%	89.5%	91.4%	79.7%	75.3%	83.5%	63.1%	57.5%	68.3%
Valid n		*14,635*			*1,592*			*1,082*	
Dr. Recommendation									
No	75.3%	74.2%	76.4%	74.7%	71.2%	77.8%	72.9%	68.2%	77.2%
Yes	24.7%	23.6%	25.8%	25.3%	22.2%	28.8%	27.1%	22.8%	31.8%
Valid n		*17,805*			*2,002*			*1,361*	

Note: % and CI estimated accounting for complex sampling design of NHFS
Valid n = unweighted sample size

TABLE 2. Descriptive Statistics of Sociodemographic and Other Control Variables among White, Black, and Hispanic Male Respondents in the National H1N1 Flu Survey (NHFS)

Characteristics	White Male			Black Male			Hispanic Male		
	%	95% CI -/+		%	95% CI -/+		%	95% CI -/+	
H1N1 Vaccination									
No	73.7%	72.3%	75.0%	78.4%	73.9%	82.3%	80.9%	76.8%	84.4%
Yes	26.3%	25.0%	27.7%	21.6%	17.7%	26.1%	19.1%	15.6%	23.2%
Valid n		*12,197*			*1,125*			*1,137*	
Age									
<64	81.9%	80.9%	82.9%	86.4%	83.4%	89.0%	95.3%	93.4%	96.7%
65+	18.1%	17.1%	19.1%	13.6%	11.0%	16.6%	4.7%	3.3%	6.6%
Valid n		*12,266*			*1,143*			*1,144*	
Household Poverty									
Not in Poverty	93.3%	92.4%	94.1%	73.6%	67.7%	78.8%	68.4%	62.9%	73.4%
In Poverty	6.7%	5.9%	7.6%	26.4%	21.2%	32.3%	31.6%	26.6%	37.1%
Valid n		*10,375*			*898*			*943*	
Educational									
Less than a BA/BS	53.7%	52.1%	55.2%	78.0%	73.9%	81.6%	79.8%	75.6%	83.5%
BA/BS or more	46.3%	44.8%	47.9%	22.0%	18.4%	26.1%	20.2%	16.5%	24.4%
Valid n		*11,550*			*1,068*			*1,055*	
Marital Status									
Not Married	39.8%	38.3%	41.4%	62.6%	57.4%	67.5%	53.3%	48.0%	58.5%
Married	60.2%	58.6%	61.7%	37.4%	32.5%	42.6%	46.7%	41.5%	52.0%
Valid n		*11,548*			*1,065*			*1,064*	
Close Contact with child <6 months									
No	92.2%	91.2%	93.1%	92.7%	90.1%	94.6%	85.3%	80.8%	88.9%
Yes	7.8%	6.9%	8.8%	7.3%	5.4%	9.9%	14.7%	11.1%	19.2%
Valid n		*11,840*			*1,106*			*1,125*	
Healthcare Worker									
No	89.5%	88.3%	90.6%	90.9%	87.5%	93.4%	92.3%	88.7%	94.8%
Yes	10.5%	9.4%	11.7%	9.1%	6.6%	12.5%	7.7%	5.2%	11.3%
Valid n		*11,823*			*1,101*			*1,122*	
Chronic Condition									
No	76.3%	75.0%	77.5%	76.7%	72.2%	80.6%	87.0%	83.2%	90.0%
Yes	23.7%	22.5%	25.0%	23.3%	19.4%	27.8%	13.0%	10.0%	16.8%
Valid n		*11,789*			*1,095*			*1,117*	
Healthcare Coverage									
No	11.9%	10.8%	13.0%	29.0%	23.8%	34.9%	47.8%	42.0%	53.7%
Yes	88.1%	87.0%	89.2%	71.0%	65.1%	76.2%	52.2%	46.3%	58.0%
Valid n		*9,822*			*899*			*878*	
Dr. Recommendation									
No	80.0%	78.7%	81.2%	78.6%	73.7%	82.8%	81.9%	78.0%	85.2%
Yes	20.0%	18.8%	21.3%	21.4%	17.2%	26.3%	18.1%	14.8%	22.0%
Valid n		*12,191*			*1,135*			*1,141*	

Note: % and CI estimated accounting for complex sampling design of NHFS
Valid n = unweighted sample size

Descriptive Statistics of HBM Related Variables.

In table 3 and table 4, I present similar descriptive statistics for the HBM-related components of the H1N1 Beliefs latent variable by race/ethnicity and gender categories. In terms of perceived severity, it appears that both black and Hispanic respondents were generally more concerned about H1N1 than their white counterparts. Whereas more than 1 in 4 of all black and Hispanic respondents reported being "very concerned" about H1N1, only 12.2% of white females and 9.0% of white males reported the same.

Despite perceived severity being high in black and Hispanic respondents, perceived susceptibility (risk of getting sick with H1N1) was generally low for all groups. A clear majority of all racial/ethnic/gender groups perceived their susceptibility or risk to H1N1 illness as "very low" or "somewhat low." While less than 10% of white respondents felt their risk was very high, 16.8% of Hispanic females and 16.5% of Hispanic males expressed considerable worry about becoming ill.

While the majority of respondents were not concerned about adverse reactions or negative side effects to the H1N1 vaccine, opinions regarding the safety of vaccination vary considerably between racial/ethnic groups. I observe that concern is higher among black and Hispanic female respondents than white female respondents. For example, approximately 50% of Hispanic females expressed they were very worried or somewhat worried about becoming ill from the vaccine compared to 31% of white females.

While groups appear to have mixed beliefs regarding the probability of becoming ill from the H1N1 vaccine, a strong majority of all respondents, regardless of race or gender, viewed the H1N1 vaccine as effective. Approximately 80% (or more) of all

racial/ethnic/gender groups considered H1N1 vaccine effectiveness as “somewhat high” or “very high.”

TABLE 3. Descriptive Statistics for H1N1 Vaccination and Health Belief Model (HBM) Components among White, Black, and Hispanic Female Respondents in the National H1N1 Flu Survey (NHFS)

Characteristics	White Female			Black Female			Hispanic Female		
	%	95% CI -/+		%	95% CI -/+		%	95% CI -/+	
How Concerned about H1N1 (HBM: Severity)									
1 Not at all concerned	10.9%	10.1%	11.7%	11.0%	8.8%	13.6%	7.8%	5.6%	10.8%
2 Not very concerned	35.3%	34.1%	36.5%	20.9%	17.9%	24.3%	25.3%	21.4%	29.7%
3 Somewhat concerned	41.7%	40.4%	42.9%	38.8%	35.1%	42.6%	38.4%	33.8%	43.3%
4 Very concerned	12.2%	11.4%	13.0%	29.3%	25.8%	33.0%	28.5%	24.5%	32.8%
Valid n		*17,844*			*2,003*			*1,360*	
Risk of Getting Sick with H1N1 (HBM: Susceptibility)									
1 Very Low	30.0%	28.8%	31.2%	41.6%	37.6%	45.6%	31.6%	27.1%	36.4%
2 Somewhat Low	41.2%	39.9%	42.5%	31.6%	28.1%	35.4%	27.5%	23.6%	31.9%
3 Somewhat High	22.0%	20.9%	23.1%	18.9%	16.0%	22.3%	24.1%	20.1%	28.6%
4 Very High	6.8%	6.2%	7.6%	7.9%	5.9%	10.4%	16.8%	13.3%	21.0%
Valid n		*16,959*			*1,856*			*1,308*	
Worry about Getting Sick from H1N1 Vaccine (HBM: Barrier)									
1 Very Worried	7.7%	7.0%	8.4%	15.4%	12.9%	18.4%	20.5%	16.8%	24.8%
2 Somewhat Worried	23.3%	22.2%	24.4%	23.6%	20.4%	27.1%	31.0%	26.6%	35.8%
3 Not Very Worried	35.7%	34.5%	37.0%	30.0%	26.6%	33.6%	28.7%	24.7%	33.0%
4 Not Worried at all	33.3%	32.1%	34.5%	31.0%	27.4%	34.9%	19.8%	16.1%	24.0%
Valid n		*17,539*			*1,956*			*1,350*	
Effectiveness of H1N1 Vaccine (HBM: Benefit)									
1 Very Low	3.4%	2.9%	4.0%	8.7%	6.6%	11.5%	6.6%	4.1%	10.6%
2 Somewhat Low	8.1%	7.4%	8.9%	13.0%	10.2%	16.3%	10.6%	8.2%	13.6%
3 Somewhat High	55.5%	54.1%	56.8%	51.6%	47.4%	55.8%	45.8%	40.7%	51.1%
4 Very High	33.1%	31.8%	34.4%	26.7%	23.3%	30.4%	37.0%	32.0%	42.2%
Valid n		*14,987*			*1,634*			*1,173*	

Note: % and confidence interval (CI) estimates account for the NHFS complex sampling design
Valid *n*=unweighted sample

TABLE 4. Descriptive Statistics for H1N1 Vaccination and Health Belief Model (HBM) Components among White, Black, and Hispanic Male Respondents in the National H1N1 Flu Survey (NHFS)

Characteristics	White Male			Black Male			Hispanic Male		
	%	95% CI -/+		%	95% CI -/+		%	95% CI -/+	
How Concerned about H1N1 (HBM: Severity)									
1 Not at all concerned	19.3%	18.1%	20.5%	14.7%	11.3%	18.9%	17.3%	13.5%	22.0%
2 Not very concerned	39.7%	38.2%	41.2%	24.8%	20.4%	29.7%	25.8%	21.8%	30.3%
3 Somewhat concerned	32.1%	30.7%	33.5%	35.1%	30.6%	39.8%	30.2%	25.7%	35.1%
4 Very concerned	9.0%	8.1%	9.8%	25.4%	21.3%	30.0%	26.7%	22.3%	31.5%
Valid n		*12,227*			*1,132*			*1,140*	
Risk of Getting Sick with H1N1 (HBM: Susceptibility)									
1 Very Low	41.0%	39.4%	42.6%	42.4%	37.6%	47.4%	29.5%	25.1%	34.4%
2 Somewhat Low	39.7%	38.2%	41.3%	31.5%	26.8%	36.5%	30.3%	25.6%	35.6%
3 Somewhat High	15.6%	14.5%	16.7%	18.8%	15.1%	23.1%	23.6%	19.4%	28.4%
4 Very High	3.7%	3.2%	4.4%	7.3%	5.2%	10.3%	16.5%	13.1%	20.7%
Valid n		*11,603*			*1,063*			*1,080*	
Worry about Getting Sick from H1N1 Vaccine (HBM: Barrier)									
1 Very Worried	5.0%	4.3%	5.8%	12.3%	9.3%	16.2%	15.6%	12.0%	20.1%
2 Somewhat Worried	17.2%	16.1%	18.4%	22.6%	18.1%	27.7%	25.5%	21.6%	30.0%
3 Not Very Worried	35.9%	34.5%	37.4%	31.3%	26.8%	36.1%	33.7%	28.8%	39.0%
4 Not Worried at all	41.9%	40.3%	43.4%	33.8%	29.4%	38.5%	25.2%	21.2%	29.6%
Valid n		*12,023*			*1,112*			*1,126*	
Effectiveness of H1N1 Vaccine (HBM: Benefit)									
1 Very Low	4.4%	3.8%	5.2%	6.4%	4.6%	8.9%	4.4%	2.8%	6.7%
2 Somewhat Low	8.5%	7.6%	9.4%	8.2%	5.8%	11.4%	10.0%	7.0%	14.1%
3 Somewhat High	54.2%	52.5%	55.9%	47.5%	42.1%	53.0%	42.0%	36.8%	47.5%
4 Very High	32.9%	31.3%	34.6%	37.8%	32.7%	43.2%	43.6%	38.2%	49.2%
Valid n		*10,137*			*942*			*993*	

Note: % and confidence interval (CI) estimates account for the NHFS complex sampling design
Valid *n*=unweighted sample

Confirmatory Factor Analysis

Using Mplus 8, I perform a confirmatory factor analysis (CFA) in creating a measurement model for the H1N1 Beliefs latent variable using all four HBM related indicators described in tables 3 and 4. As seen in table 5, the variables measuring perceived severity, susceptibility and barriers fit reasonably well in the creation of the H1N1 Beliefs latent variable. The factor loading for perceived benefit is below the traditional cut-off criteria of 0.4 in a fully standardized model, but it is nevertheless included in the analysis, as it is a crucial part of the H1N1 Beliefs latent variable construct. An additional rationale for including perceived benefit variable is that removing it from the latent variable resulted in poorer fit statistics. As a measure of model fit for the final CFA, I estimate an RMSEA of 0.062. The 90% confidence interval (0.57-0.67) surrounding this point estimate includes 0.06, which is the traditional criterion for acceptable model fit.

TABLE 5. Factor Loadings in Confirmatory Factor Analysis used in the Creation of a Latent Variable for H1N1 Beliefs

Characteristics	Factor
Perceived Severity:	
Concern about H1N1	0.68
Perceived Susceptibility:	
Risk of Getting Sick with H1N1	0.68
Perceived Barrier:	
Worry about Getting Sick from H1N1 Vaccine	-0.62
Perceived Benefit:	
Effectiveness of H1N1 Vaccine	0.39

Model fit: RMSEA = 0.062, 90% C.I. of RMSEA: 0.057-0.067;

Estimates of H1N1 Vaccination using Structural Equation Modeling (SEM)

In table 6, I report estimates from the SEM analysis of H1N1 vaccination by race/ethnicity, gender and potential mediators. In model 1, I present age-adjusted estimates of H1N1 vaccination by race/ethnicity and gender. In this age-adjusted model, the odds of H1N1 vaccination are significantly higher among white females than *all* other race/gender groups. This disparity appears to be strongest among black males, black females, and Hispanic females. Belonging to the oldest age group (65+) is also a statistically significant predictor of vaccination.

By comparing the BIC and between models, I can see that model fit improves from model 1 to model 2, indicating that the set of mediating variables helps to explain associations between race/gender and vaccination. Although many of the indicator variables have statistically significant effects on H1N1 vaccination in model 2, my main interest is comparing the change in coefficients for the race/gender categories. The negative effect of being white male in model 1 reverses in model 2 is, with white males reporting 53% greater odds of vaccination than white females. Including my chosen mediators attenuates the negative effects of black male in model 2, becoming non-statistically different from white females. Hispanic female remains a significant negative predictor of vaccination, although its effect is partially explained by this collection of mediating variables. Strong negative effects remain in model 2 for both black females (AOR 0.45; 95 CI 0.35-0.58) and Hispanic males (AOR 0.70; 95 CI 0.50-0.97) relative to white females.

With the exception of poverty status and contact with young children, all mediators in model 2 are statistically significant predictors of H1N1 vaccination. Variables that are especially strong predictors of H1N1 vaccination include being a healthcare worker (AOR 2.39; 95 CI 2.05-2.78), having some form of healthcare coverage (AOR 2.32; 95 CI 1.82-2.96), and receiving a doctor's recommendation to be vaccinated against H1N1 (AOR 5.91; 95 CI 5.27-6.64). The H1N1 Beliefs latent variable is also a statistically significant predictor of H1N1 vaccination (AOR 1.57; 95 CI 1.46-1.68).

TABLE 6. SEM Regression Coefficients of Race/Gender on H1N1 Vaccination

Characteristics	Model 1		Model 2	
	Estimate	S.E.	Estimate	S.E.
Age				
<65	Ref.		Ref.	
65+	0.21***	0.05	0.42***	0.06
Race/Gender				
White Female	Ref.		Ref.	
White Male	-0.10*	0.05	0.42***	0.06
Black Male	-0.35**	0.13	-0.11	0.17
Black Female	-0.61***	0.11	-0.80***	0.13
Hispanic Female	-0.48***	0.13	-0.36*	0.17
Hispanic Male	-0.27*	0.12	-0.52**	0.16
Poverty Status				
Above Poverty			Ref.	
Below Poverty			-0.09	0.11
Education				
Less than a BA/BS			Ref.	
BA/BS or more			0.35***	0.06
Marital Status				
Not Married			Ref.	
Married			0.17**	0.06
Close Contact Child <6				
No			Ref.	
Yes			0.16	0.10
Healthcare Worker				
No			Ref.	
Yes			0.87***	0.08
Chronic Conditions				
No			Ref.	
Yes			0.13*	0.06
Healthcare Coverage				
No			Ref.	
Yes			0.84***	0.12
Dr. Recommendation				
No			Ref.	
Yes			1.78***	0.06
H1N1 Beliefs			0.74***	0.05
BIC	642080		604404	

Note: n=35,837; S.E.=standard error; † p <0.1; *p <0.05; **p <0.01; ***p <0.001

SEM Pathways between Race/Gender and Potential Mediators

While table 6 presents the direct pathway coefficients predicting H1N1 vaccination by race/gender, they do not show the associations race/gender may have with my chosen mediators. The following figures represent segments or subsystems of the SEM analysis showing the pathway coefficients of race/gender variables with measures of SES, healthcare coverage, physician recommendations, and the H1N1 Beliefs latent variable.

From figure 2 it is evident that white male is a positive predictor of education when compared to white females. Both black males and females experience lower odds of having a college degree or higher when compared to non-Hispanic whites. Similarly, Hispanics, both males and females, have lower odds of a college degree than white females.

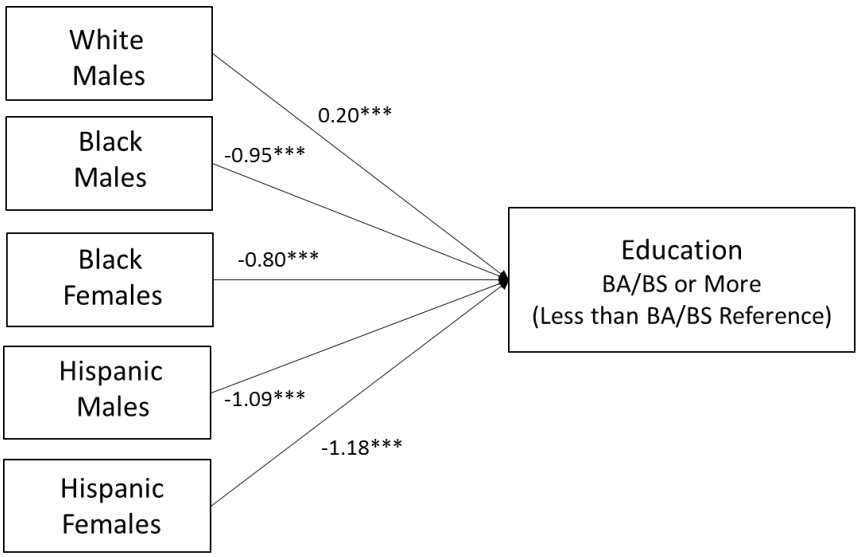


Figure 2. Selected subsystem from SEM analysis showing unstandardized coefficients linking race/gender to education.

Confirming observations from the descriptive statistics, figure 3 shows white males with lower odds of experiencing household poverty than white females. Being black or Hispanic is associated with higher odds of household poverty. In addition, in figure 4 being black or Hispanic is negatively associated with being married when compared to white females

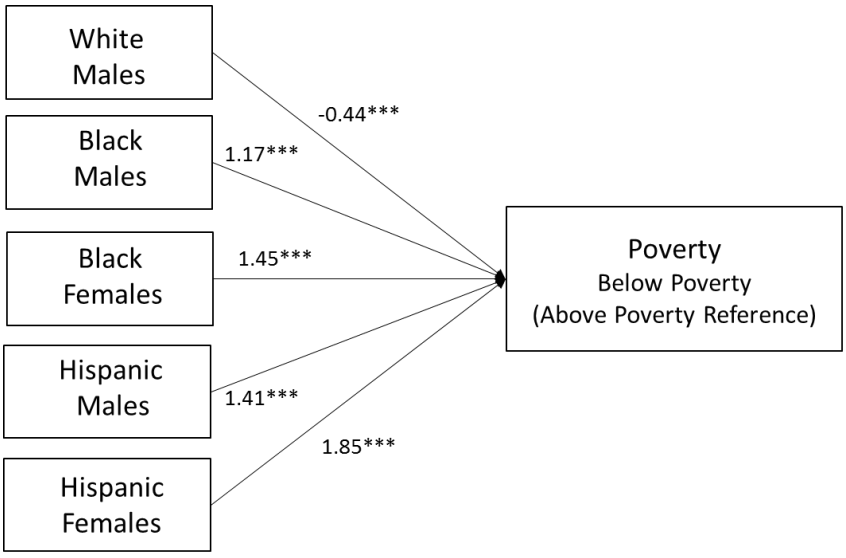


Figure 3. Selected subsystem from SEM analysis showing unstandardized coefficients linking race/gender to poverty.

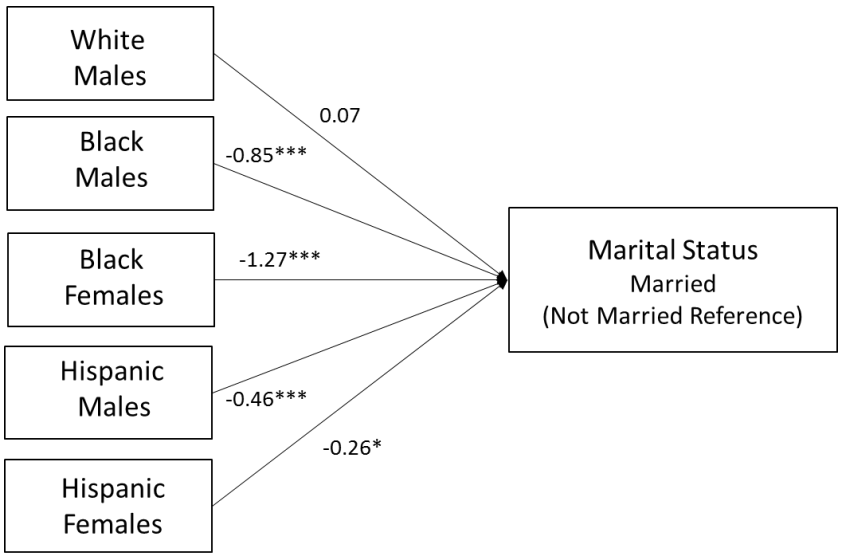


Figure 4. Selected subsystem from SEM analysis showing unstandardized coefficients linking race/gender to marital status.

Figures 5, 6, and 7 show associations between race/gender and various characteristics the CDC as "high risk" and priorities for H1N1 vaccination. Black females had higher odds of reporting a chronic condition than white females (see figure 5). Hispanics, both male and female, had higher odds of being in close proximity with an infant less than 6 months of age (see figure 6) than white females. Both the descriptive statistics and SEM analysis indicate that a higher proportion of black are employed as healthcare workers (see figure 7).

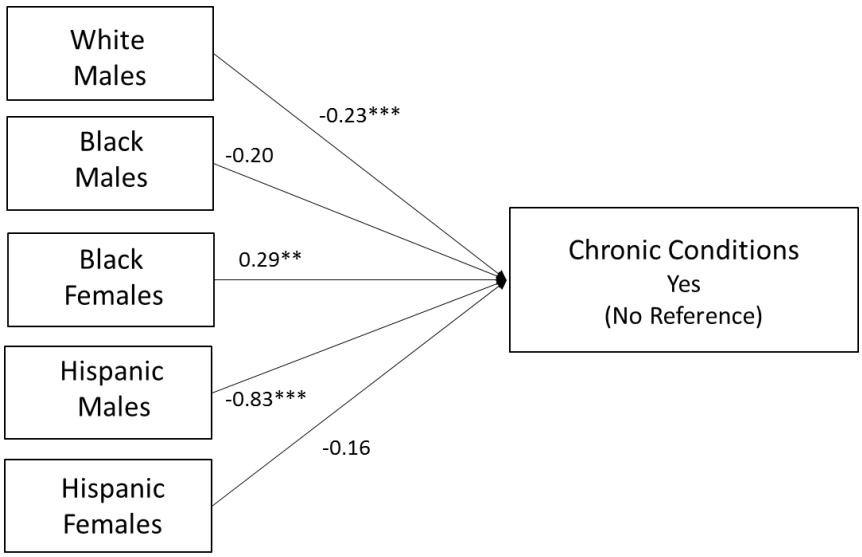


Figure 5. Selected subsystem from SEM analysis showing unstandardized coefficients linking race/gender to chronic conditions.

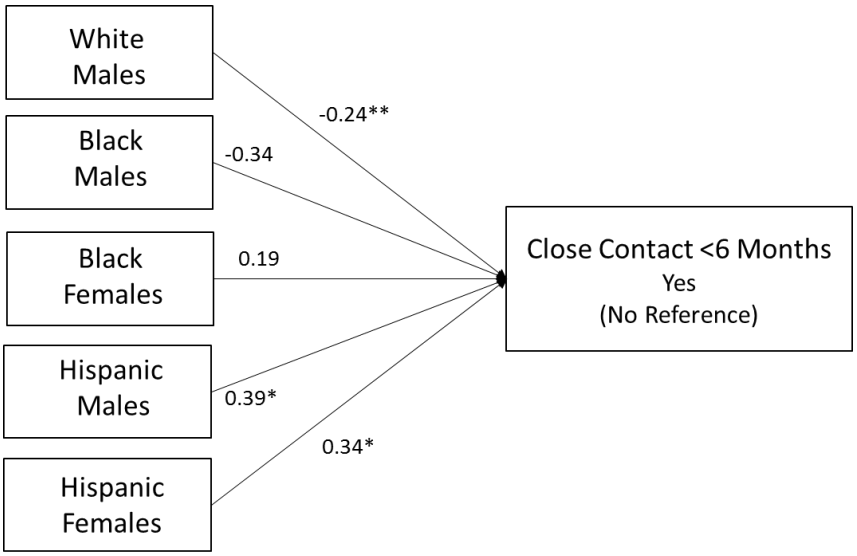


Figure 6. Selected subsystem from SEM analysis showing unstandardized coefficients linking race/gender to close contact with child <6 months of age.

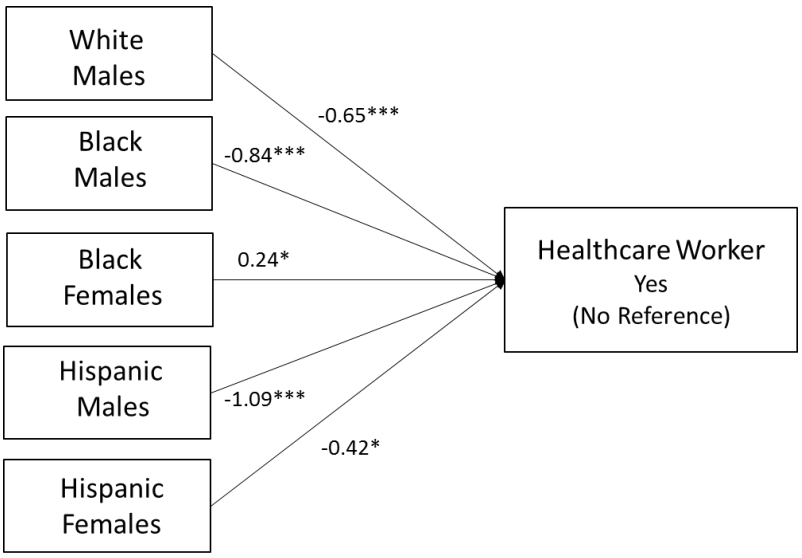


Figure 7. Selected subsystem from SEM analysis showing unstandardized coefficients linking race/gender healthcare worker status.

In figures 8 and 9, I observe that white males and Hispanic males less likely than white females to receive a doctor's recommendation to vaccinate against H1N1. The odds of receiving a doctor's recommendation among black males, black females, and Hispanic females were non-statistically different from white females. All groups experienced lower odds of healthcare coverage when compared to white females with Hispanics experiencing the worst odds of healthcare coverage.

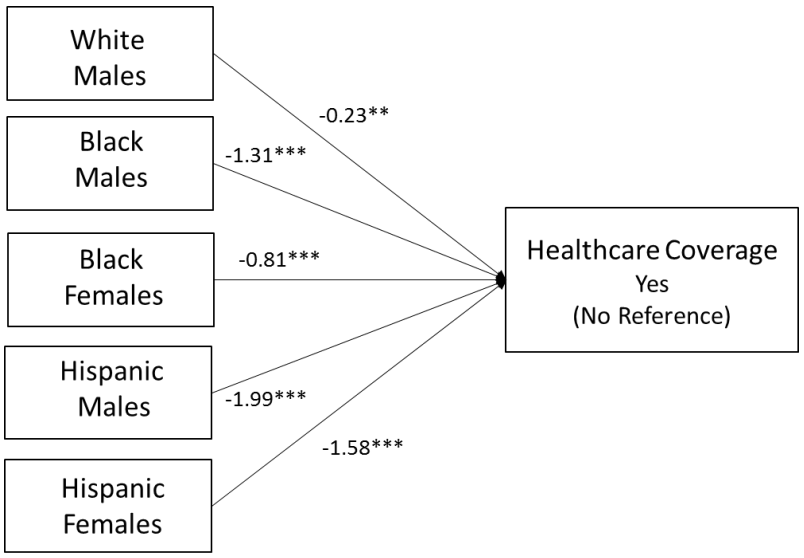


Figure 8. Selected subsystem from SEM analysis showing unstandardized coefficients linking race/gender to healthcare coverage.

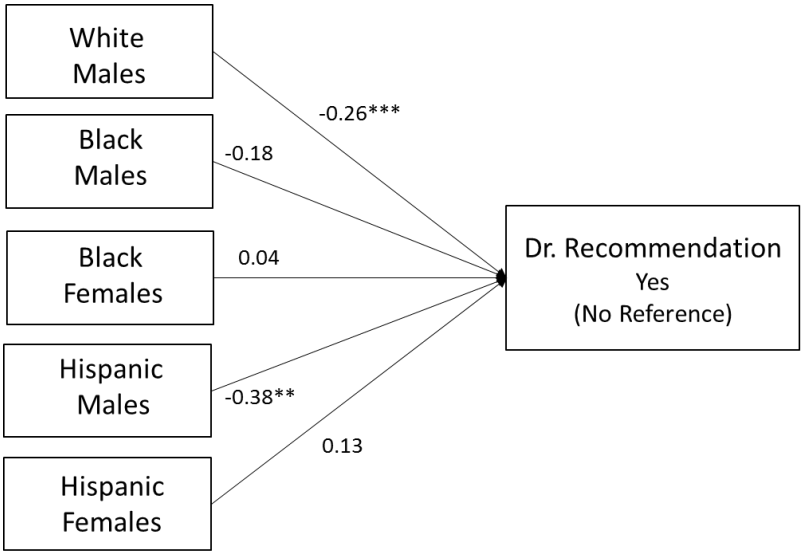


Figure 9. Selected subsystem from SEM analysis showing unstandardized coefficients linking race/gender to doctor recommendations.

Figure 10 shows the linkages between race/gender and H1N1 beliefs – the latent variable created using four HBM related variables (see table 5). Compared to white

females, white males have lower odds of reporting health beliefs that may result in H1N1 vaccination. Both Hispanic males and Hispanic females had greater odds of reporting H1N1 beliefs conducive to vaccination than white females. Additionally, I observe both black males and black females do not significantly differ from white females with respect to the H1N1 Beliefs variable.

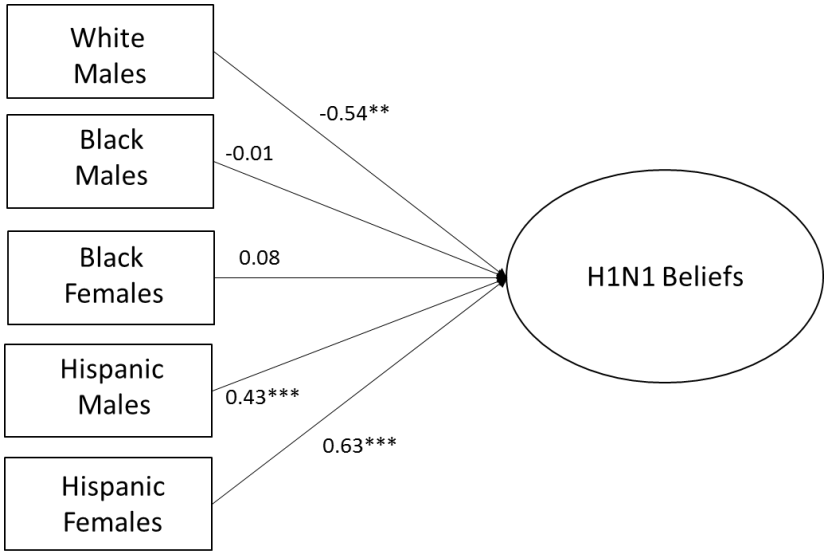


Figure 10. Selected subsystem from SEM analysis showing unstandardized coefficients linking race/gender to H1N1 Beliefs

Notable Linkages between Race/Gender and H1N1 Vaccination

Certain commonalities seem to exist in the pathways between race/gender and H1N1 vaccination. For example, education is a powerful predictor of vaccination, with college graduates reporting higher odds of vaccination than those without a college degree. In analyzing the subsystem linking race/gender to education, only white males reported greater odds of having a college degree when compared to white females. All

other racial/gender groups reported lower odds of college education than white females. With regard to marital status, racial minorities report significantly lower odds of being married than white females – a characteristic that is associated with higher odds of vaccination. Another important predictor of vaccination – healthcare coverage – was less common among all racial/gender groups when compared to white females.

While the influence of education, marital status, and healthcare coverage seem to have a universal influence on the pathway to vaccination, certain linkages are unique among each racial/gender group. For example, black females report higher odds of both being a healthcare worker and having a chronic disease (conditions recommended by the CDC to receive the vaccine) than white females. White males are the only group to report lower odds than white females of having attitudes and beliefs conducive to vaccination as predicted by HBM. Interestingly, Hispanic females and Hispanic males are the only groups to report greater odds of HBM favorable beliefs when compared to white females. While white males report greater odds of healthcare coverage than Hispanic males (in comparison to white females), both report lower odds of receiving a doctor's recommendation to vaccinate.

DISCUSSION

In discussing the implications of my findings, it is worth noting that overall vaccination against H1N1 was low among all groups. With only about a quarter of U.S. adults reporting having received the H1N1 vaccine during the timeframe of the pandemic, important lessons can be learned so as to improve vaccination uptake during a

future pandemic. This study utilizes SEM to observe the extent to which sociodemographic and attitudinal characteristics mediate associations between race/gender and H1N1 vaccination. My results indicate that race, ethnicity, and gender influence H1N1 vaccination uptake, both directly and indirectly through mediating factors such as education, health beliefs, and risk status for H1N1 infection and complications. The influence of sociodemographic characteristics differs in important ways for the various race/gender groups in my study, suggesting that tailoring policy to address these mediating influences may improve the efficacy of health interventions and ultimately improve vaccination uptake.

White males were the only racial/gender group to have higher odds of vaccination when compared to white females after accounting for possible mediators. This indicates that white males would, hypothetically speaking, enjoy the highest rates of vaccination of any group in the study. The primary reason white males do not, in fact, have the highest vaccination rates is that they maintain certain health beliefs that are not conducive to vaccination. For example, only 3.7% of white males felt that their risk of being infected with H1N1 was very high and 9.0% expressed high concern about the outbreak.

In addition to this attitudinal disadvantage, white males were less likely than white females to have healthcare coverage or receive a vaccination recommendation from a physician. While initiating discussions between a physician and patient encouraging vaccinations will improve vaccination rates, such recommendations are only valuable if the individual is first present to receive one. Continuing to increase healthcare coverage among white males will additionally result in improved odds of vaccination. Discussions

with physicians, increasing healthcare coverage, in addition to targeted health awareness campaigns, may also influence health beliefs related to pandemic influenza and vaccination increasing vaccination uptake among white males.

My analysis shows that black males experienced non-statistically different odds of vaccination when compared to white females, after accounting for SES characteristics, risk factors, and health beliefs. The attenuation of this effect suggests that addressing broad societal disparities will improve vaccination uptake among black males. Specifically, my analysis suggests that black males experience lower educational attainment and less healthcare coverage than white females. In addition, my analysis suggests that increasing the proportion of black males who are married would likely result in improved vaccination rates. It is not clear from my study whether the positive influence of marriage is related to the institution itself or perhaps another mediator, such as social support.

Black females experience lower odds of vaccination than white females, even after controlling for SES inequalities, healthcare coverage, marital status and all other potential mediating variables in the study. While consistently low odds of vaccination among black females is troubling, my analysis suggests that efforts to improve educational attainment and healthcare coverage among black females will have a positive influence on vaccination uptake. Interestingly, a higher proportion of black females are healthcare workers, which was a positive indicator of vaccination. By creating awareness/vaccination campaigns targeting healthcare workers, and keeping in mind that black females constitute a higher proportion in this group, vaccination uptake among this

group may improve. In addition, black females are more likely to experience chronic health conditions than white females. Although awareness campaigns will result in a higher proportion of black females vaccinated, my results indicate black females did not differ significantly from white females in terms of H1N1 related beliefs. It is possible that providing more contextualized information to black women on how pandemic influenza is particularly harmful to those with chronic conditions will improve vaccination uptake.

Similar to black females, Hispanic males continue to experience lower odds of vaccination than white females even after all potential mediators are considered. My results indicate that addressing disparities in educational attainment and healthcare coverage may help address low vaccination uptake in this group. Interestingly, Hispanic males were more likely to report beliefs conducive to vaccination than white females. Although interventions aimed at improving awareness of the risks of pandemic influenza and benefits of vaccination will likely improve vaccination uptake among Hispanic males, my analysis does not make the important distinction between U.S.-born and foreign-born Hispanics. Considering differences in language-use and nativity status, items that I am unable to account for in my analysis, will of course be important in considering any type of intervention from public health officials.

Hispanic females also experienced lower rates of H1N1 vaccination uptake than white females. More than any other group, improving college access and graduation rates among Hispanic females will help narrow the vaccination gap between Hispanic and white females. Similar to Hispanic males, increasing healthcare coverage among Hispanic females will result in better vaccination outcomes. Also similar to Hispanic

males, Hispanic females had higher odds of being in close contact with a child <6 months of age. Considering this group as one recommended by the CDC for vaccination, emphasizing the importance of inoculation against H1N1 in order to protect young infants might increase vaccination uptake.

An interesting finding from my analysis was that household poverty status, which is often associated with positive health outcomes, was not a significant predictor of vaccination in the context of the 2009 H1N1 pandemic. This is, I believe, evidence supporting the effectiveness of subsidizing the H1N1 vaccine. While subsidizing the vaccine likely eliminated any observed disparities in vaccination by household poverty status, future influenza pandemic preparedness plans should note important sociological factors – such as race/gender, education, marital status, healthcare coverage, and healthcare interactions – on vaccination behavior.

A limitation of my paper is the paucity of HBM-related variables available to construct the H1N1 Health Beliefs latent variable. With additional factors, I believe the measurement model would be a better fit for the theoretical construct of health beliefs proposed by HBM. While including other racial minority groups would have enhanced my study, the NHFS limited the number racial/ethnic groups that I could include. To encourage further research into other racial minority groups in the United States, I suggest that data on H1N1 vaccinations collected during the 2010 wave of the Behavioral Risk Factor Surveillance System (BRFSS) be released by the CDC for public-use. In addition, my analysis was unable to identify US-born and foreign-born Hispanics from

the NHFS data, a distinction found to be important in understanding H1N1 vaccination behavior among Hispanics (Burger et al. 2017).

Despite these limitations, my investigation also has several important strengths. First, my study incorporates various theoretical components explaining health behaviors into a single analysis. By considering the influence of both health beliefs and socioeconomics, my paper presents and tests ideas presented by both the HBM and FCT. Additionally, I am able to do so using a robust, nationally representative sample of U.S. adults, utilizing data collected specifically for the analysis of this unique historical event. Additionally, by utilizing an SEM analysis, I have been able to specify pathways between race/gender, potential mediators, and vaccination – allowing for a more nuanced understanding of these relationships.

CONCLUSION

Overall H1N1 vaccination during the 2009 pandemic was extremely low in the United States. My analysis demonstrates that significant disparities in the odds of vaccination during the 2009 H1N1 pandemic existed by race/gender and other sociodemographic characteristics. By utilizing SEM, I estimate the effect of potential mediators in the pathway between race/gender and vaccination. Common factors that appear to influence vaccination uptake across race/gender groups include education and healthcare coverage. Improving educational attainment and increasing access to healthcare coverage are important societal steps in improving vaccination uptake.

While education and healthcare coverage influence vaccination uptake across multiple groups, my analysis does isolate pathways to vaccination that are unique by race/gender categorization. Understanding these pathways provides greater context in the formation of policy interventions to increase vaccination uptake. For example, in addition to encouraging doctor recommendations, campaigns to raise awareness of a pandemic virus and the benefits of vaccination may be especially helpful among white males. Contextualizing educational messages, especially among black females who had greater odds of reporting a chronic condition than white females, on the benefits of influenza vaccination in preventing health complications may also be effective. Understanding the influence of social determinants of vaccination, both collectively and individually, for racial/gender categories is an important step in preparing for a future pandemic.

REFERENCES

Bauer, Greta R. 2014. "Incorporating Intersectionality Theory into Population Health Research Methodology: Challenges and the Potential to Advance Health Equity." *Social Science & Medicine (1982)* 110:10.

Boulware, L.Ebony., Lisa A. Cooper, Lloyd E. Ratner, Thomas A. LaVeist, and Neil R. Powe. 2003. "Race and Trust in the Health Care System." *Public Health Reports* 118(4):358.

Burger, Andrew E., and Eric N. Reither. 2014. "Monitoring Receipt of Seasonal Influenza Vaccines with BRFSS and NHIS data: Challenges and Solutions." *Vaccine* 32(31):3950-54.

Burger, Andrew E., Eric N. Reither, Erin Trouth Hofmann, and Svenn-Erik Mamelund. 2017. "The Influence of Hispanic Ethnicity and Nativity Status on 2009 H1N1 Pandemic Vaccination Uptake in the United States." *Journal of Immigrant and Minority Health*:1-8.

Carmel, Sara, Esther Shani, and Lior Rosenberg. 1994. "The Role of Age and an Expanded Health Belief Model in Predicting Skin Cancer Protective Behavior." *Health Education Research* 9(4):433-47.

Centers for Disease Control and Prevention. 2011. "Final Estimates for 2009-10 Seasonal Influenza and Influenza A(H1N1) 2009 Monovalent Vaccination Coverage - United States, August 2009 through May, 2010." (https://www.cdc.gov/flu/fluvaxview/coverage_0910estimates.htm).

Clayman, Marla L., Jennifer A. Manganello, K. Viswanath, Bradford W. Hesse, and Neeraj K. Arora. 2010. "Providing Health Messages to Hispanics/Latinos: Understanding the Importance of Language, Trust in Health Information Sources, and Media Use." *Journal of Health Communication* 15:252-63.

Deshpande, Sameer, Michael D. Basil, and Debra Z. Basil. 2009. "Factors Influencing Healthy Eating Habits among College Students: An Application of the Health Belief Model." *Health Marketing Quarterly* 26(2):145-64.

Galarce, Ezequiel M., Sara Minsky, and K. Viswanath. 2011. "Socioeconomic Status, Demographics, Beliefs and A (H1N1) Vaccine Uptake in the United States." *Vaccine* 29(32):5284-89.

Gargano, L.M., J.E. Painter, J.M. Sales, C. Morfaw, L.D.M. Jones, D. Murray, G.M. Wingood, R.J. DiClemente, and J.M. Hughes. 2011. "Seasonal and 2009 H1N1 Influenza Vaccine Uptake, Predictors of Vaccination and Self-Reported Barriers to Vaccination among Secondary School Teachers and Staff." *Human Vaccines* 7(1):89.

Hankivsky, Olena. 2012. "Women's Health, Men's Health, and Gender and Health: Implications of Intersectionality." *Social Science & Medicine* 74(11):1712-20.

Klein, Sabra L., Catherine Passaretti, Martha Anker, Peju Olukoya, and Andrew Pekosz. 2010. "The Impact of Sex, Gender and Pregnancy on 2009 H1N1 Disease." *Biology of Sex Differences* 1(1):5.

Kumar, Supriya, Sandra Crouse Quinn, Kevin H. Kim, Donald Musa, Karen M. Hilyard, and Vicki S Freimuth. 2012. "The Social Ecological Model as a Framework for

Determinants of 2009 H1N1 Influenza Vaccine Uptake in the United States." *Health Education & Behavior* 39(2):229-43.

Link, Bruce G., and Jo Phelan. 1995. "Social conditions as fundamental causes of disease." *Journal of Health and Social Behavior* (Extra Issue):80-94.

Ma, KK, W. Schaffner, C. Colmenares, J. Howser, J. Jones, and K.A. Poehling. 2006. "Influenza vaccinations of young children increased with media coverage in 2003." *Pediatrics* 117(2):e157.

Major, Brenda, John F Dovidio, and Bruce G Link. 2017. *The Oxford Handbook of Stigma, Discrimination, and Health*: Santa Barbara , CA: Oxford University Press.

Morton, Patricia M, and Kenneth F Ferraro. 2014. "Race and Health Disparities." *The Wiley Blackwell Encyclopedia of Health, Illness, Behavior, and Society*. Hoboken, NJ: Wiley-Blackwell..

Muthén, Linda K., and Bengt O. Muthén. 2017. *Mplus User's Guide: Eighth Edition*. Los Angeles, CA: Muthén & Muthén.

Phelan, Jo C., and Bruce G. Link. 2005. "Controlling Disease and Creating disparities: A Fundamental Cause Perspective." *The Journals of Gerontology* Series B:60(Special Issue 2):S27.

Rosenstock, Irwin M., Victor J. Strecher, and Marshall H. Becker. 1988. "Social Learning Theory and the Health Belief Model." *Health Education & Behavior* 15(2):175-83.

Santibanez, Tammy A., James A. Singleton, Scott S. Santibanez, Pascale Wortley, and Beth P. Bell. 2013. "Socio-Demographic Differences in Opinions about 2009 Pandemic Influenza A (H1N1) and Seasonal Influenza Vaccination and Disease among Adults During the 2009–2010 Influenza Season." *Influenza and Other Respiratory Viruses* 7(3):383-92.

Shields, Stephanie A. 2008. "Gender: An Intersectionality Perspective." *Sex Roles* 59(5-6):301-11.

StataCorp, LP. 2017. "Stata 15." StataCorp LP., College Station, Texas, United States. http://www.stata.com.

Uscher-Pines, Lori, Jurgen Maurer, and Katherine Harris. 2011. Uscher-Pines, Lori, Jurgen Maurer, and Katherine Harris. 2011. "Racial and Ethnic Disparities in Uptake and Location of Vaccination for 2009-H1N1 and Seasonal Influenza." *American Journal of Public Health*. 101(7):1252-1255.

Yuan, Ke-Hai, and Peter M Bentler. 2000. "Three Likelihood-Based Methods for Mean and Covariance Structure Analysis with Nonnormal Missing Data." *Sociological Methodology* 30(1):165-200.

SUMMARY AND CONCLUSION

In 1918, the most virulent and deadly pandemic influenza in the historical record spread globally with vicious speed and lethality infecting an estimated 1/3 of the world's population (Taubenberger and Morens 2006). Precise mortality estimates of the 1918 pandemic may be impossible to calculate due to data inconsistencies, but total deaths were likely in the range of 50 to 100 million (Johnson and Mueller 2002). In an historical account of the pandemic, author John. M. Barry recounts the panic and fear that accompanied the pandemic through the recorded experience of Dan Tonkel of Golsboro, North Carolina (U.S.) who was a child at the time of the 1918 pandemic:

> We were actually almost afraid to breathe, the theaters were closed down so you didn't get into any crowds…. You felt like you were walking on eggshells, you were afraid even to go out. You couldn't play with your playmates, your classmates, your neighbors, you had to stay home and just be careful. The fear was so great people were actually afraid to leave their homes. People were actually afraid to talk to one another. It was almost like don't breathe in my face, don't look at me and breathe in my face…. You never knew from day to day who was going to be next on the death list…. That was the horrible part, people just died so quickly (Barry 2005:346)

During the 1918 pandemic, notable efforts were undertaken to understand the event from a social epidemiological perspective (Mamelund, Haneberg and Mjaaland 2016). Confirming the relationship of the social environment with health, recent research has been able to use early public health surveys administered during the pandemic to identify associations between SES-related characteristics and influenza-like illness (ILI) (Mamelund 2018). At the time of this dissertation, nearly 100 years since the emergence of this deadly pandemic, significant changes in the approach to address influenza have

occurred – namely the introduction of effective influenza vaccines. In some ways replicating findings from nearly a century ago, my dissertation confirms that the association between the social environment and health outcomes still exists with respect to vaccination uptake.

Data collected during the 2009 H1N1 pandemic presents a rich resource of information on epidemiological trends in vaccination behavior and beliefs. In addition to advances in survey methodology, increasing the scope and reliability of survey data, advancements in survey design now allow statistical tools to analyze and identify characteristics that influence the decision to vaccinate with greater precision. Technological advancements have made possible the computation of advanced statistics that would have been unfeasible just a few decades ago.

The purpose of my dissertation is to provide a thorough assessment of predictors, both sociodemographic and psychological, of the 2009 H1N1 pandemic and vaccination campaign, while looking through the lens of race in the United States. In the following paragraphs, I will recount the important findings of the three research papers. Afterwards I will discuss collectively the implications of these findings as general strategies in mitigating the disease burden of a future, and inevitable, influenza pandemic, so that society does not repeat experiences like those of Dan Tonkey during the 1918 pandemic.

Paper 1: The Influence of Hispanic Ethnicity and Nativity Status on 2009 H1N1 Pandemic Vaccination Uptake in the United States

Using the 2010 National Health Interview Survey (NHIS) my co-authors and I estimated predictors of H1N1 vaccination among non-Hispanic whites, U.S.-born Hispanics, and foreign-born Hispanics. By including nativity status into our analysis, this paper provides a nuanced view of Hispanic vaccination behavior during the 2009 pandemic. Using Fundamental Cause Theory (FCT) as our theoretical framework, we controlled for various measures of SES and their effect on H1N1 vaccination. Overall, non-Hispanic whites reported higher rates of vaccination followed by U.S.-born Hispanics and foreign-born Hispanics. In our logistic regression models, we discovered that demographic factors (particularly age) explain disparities in odds of vaccination between non-Hispanic whites and U.S.-born Hispanics. Controlling for SES-related measures and health insurance coverage attenuates the disparity in odds ratios between non-Hispanic whites and foreign-born Hispanics. Findings from this paper suggest that reasons for lower odds of vaccination among Hispanics compared to whites may be due to demographic and structural barriers. By addressing social inequalities in education and healthcare coverage gains in vaccination uptake are likely among Hispanics.

Paper 2: The Impact of Gender and Racial Identification on H1N1 Vaccination Beliefs and Behaviors in the United States

Utilizing the National H1N1 Flu Survey (NHFS), this paper continues the exploration of SES related predictors of H1N1 vaccination but shifts attention to disparities between U.S. white and black adults. Considering the intersectionality of both race and gender, I combine measures of race and sex into a single measure. This permits a more nuanced estimation of vaccination behavior by race and gender. In addition to

measures commonly used in FCT, the NHFS includes attitudinal measures of how respondents perceive certain aspects of the 2009 pandemic and vaccine. Incorporating both FCT and the Health Belief Model (HBM) into the analysis, I present a carefully specified model of vaccination behavior. I find certain sociodemographic characteristics, such as high educational attainment and health insurance, increase the odds of vaccination. In addition, the HBM concepts of *perceived susceptibility* (measured by asking how respondents felt about H1N1 infection risks) and *perceived benefits* (measured by asking how effective respondent's felt the H1N1 vaccine was in preventing disease) were associated with increasing odds of vaccination. Importantly, I find minimal attenuation of the lower odds of vaccination among black women (compared to white women) across my logistic regression models. This suggests that something outside of SES or psychological perceptions is explaining relatively low H1N1 vaccination uptake among black women.

Paper 3: Impact of Race/Ethnicity and Gender on 2009 H1N1 Vaccination: A Structural Equation Modelling Approach

Findings from this paper confirm racial/ethnic and gender differences in vaccination uptake. Using SEM, I am able to specify the relationship race/ethnicity and gender has on H1N1 vaccination while considering the mediating influence of SES, H1N1 beliefs, and healthcare. When accounting for these mediators (especially the influence of healthcare coverage, doctor recommendations, and whether the respondent is a healthcare worker), I find that pathways to H1N1 vaccination differ substantially by race/gender. For example, whereas white males have lower odds of vaccination than

white women in my baseline model (which controls only for age), they exhibit *higher* vaccination odds in my full model that accounts for health beliefs that are, in the case of white males, less conducive to vaccination. I also find that black males, when controlling for possible mediators, experience non-statistically different odds of vaccination when compared to white females. Both black females and Hispanic males, however, continue to have lower odds of vaccination when compared to white females after accounting for all possible mediators – a finding that low educational attainment and healthcare coverage likely exacerbate. By considering the unique ways in which race/gender are linked to H1N1 vaccination, I present tailored suggestions to improve vaccination for each group.

POLICY IMPLICATIONS

Overall vaccination uptake in the United States for the H1N1 pandemic was lower than the annual seasonal influenza vaccination for that year. Even though estimated deaths may have been similar to seasonal influenza, H1N1 deaths tended to occur among individuals not usually at risk for seasonal influenza complication – causing a dramatic difference in years of life lost compared to seasonal epidemics (Viboud et al. 2010). It is a tragedy that the underutilization of the H1N1 vaccine likely contributed to some of these deaths. Despite tremendous amounts of resources expended on vaccination production, a sub-optimal number of individuals received the vaccine. Considering the results of my analyses, I propose focusing on three distinct areas in which the United States can better prepare for a future influenza pandemic.

Addressing Social Disparities

A consistent theme through my research was the impact that various socioeconomic characteristics seemed to exhibit on the odds of vaccination. In Paper 1, owning a home and increasing education increased the odds of vaccination, regardless of whether the respondent was white or Hispanic. In all my analyses, I find education to be a powerful predictor of vaccination, where having a college degree increases the odds of vaccination. When evaluating the SEM subsystem linking race/ethnicity and gender to education in Paper 3, I find that both males and females that are Hispanic or black have lower odds of having a college degree, which likely explains some of the disparity in vaccination uptake between those groups and white females. Addressing disparities in education among racial/ethnic minorities could help improve vaccination uptake among these groups. Furthermore, according to FCT, improving education would improve health in multiple other ways.

Recognize Race/Ethnicity and Gender in U.S. Pandemic Vaccination Policy

In the most recent version of the U.S. Government's influenza pandemic preparedness plan (HHS 2017), little mention is made of the social determinants of vaccination uptake. I believe it would be helpful for policy makers to consider the influence of sociodemographic characteristics in addition to biological characteristics when preparing policy for future pandemics. Paper 2 indicates that black females experience lower odds of vaccination than white females, and paper 3, with the SEM model, confirms that controlling for sociodemographic or attitudinal measures do not

fully attenuate the effect. In addition to black females, paper 3 points to both Hispanic males and females as experiencing lower odds of vaccination. Developing targeted messages to improve awareness among these groups should help improve vaccination rates. Findings from Paper 2 and Paper 3 reveal that while most individuals have high confidence in the effectiveness of the H1N1 vaccine, many others were unconcerned with H1N1 generally and wary of the vaccine. Understanding these beliefs, and how they vary by race/ethnicity and gender, could also help improve messaging that might encourage individuals to vaccinate.

Improve Healthcare Coverage and Physician Involvement

Consistently, I find healthcare coverage to be a significant predictor of H1N1 vaccination. Given the immense amount of resources expended by the U.S. Government to create a subsidized vaccine, it seems plausible that the influence of healthcare coverage goes beyond making healthcare more affordable. It is likely that healthcare coverage provides recipients with resources, familiarity, and access to healthcare. While considerable gains in improving healthcare coverage throughout the U.S. population since the 2009 H1N1 pandemic have occurred, work should continue in making healthcare coverage affordable and easily available. Findings from Papers 2 and 3 reveal that a physician's recommendation to vaccinate is closely associated with vaccination, even when controlling for healthcare coverage. I believe that increasing physician involvement is potentially the most opportune "low-hanging fruit" intervention that could increase vaccination among all racial/ethnic and gender groups. Reducing the disease burden of a pandemic flu may be possible through simple recommendations to vaccinate

from physicians. Moreover, the overall proportion of respondents who received such recommendation was quite low (around 20%) indicating substantial room for improvement.

FUTURE RESEARCH

While my dissertation provides a thorough review of the associations that race/ethnicity and gender had on vaccination uptake during the 2009 pandemic, important questions arise from my research. It is puzzling that none of my models explains the low odds of vaccination among black females. It is possible that SES related factors (other than those accounted for in my models using FCT) or different attitudes and beliefs regarding H1N1 and the medical community (other than those explained in my models using HBM) explain low vaccination uptake among black females. It is also possible that there was something unique about the 2009 H1N1 pandemic that contributed to low vaccine uptake among this group. Specific research investigating vaccination behavior during seasonal influenza epidemics could be helpful in better understanding vaccination among black females.

In addition to exploring disparities in vaccination among whites, blacks, and Hispanics, I would like to continue researching vaccination uptake among smaller racial/ethnic groups. In particular, I would like to investigate influenza vaccination behavior among American Indians/Alaskan Natives (AIAN), Asian-Americans, and Native Hawaiian and Other Pacific Islanders (NHPI). It is likely that these groups

experienced disparate rates of vaccination when compared to whites, meriting investigation into the mediating influence of the social environment.

Another possibility for future research includes the consideration of reasons given for declining the H1N1 vaccination among respondents in the NHFS. Shifting my attention away from actual vaccination to explore reasons for non-vaccination may help illuminate findings from my dissertation. These explanations, when considered along with other factors included in my dissertation, could help explain relatively low rates of vaccination among certain race/sex groups such as black females, Hispanic males, and Hispanic females.

SUMMARY

During the 2009 H1N1 pandemic, vaccination uptake in the U.S. population was quite low overall. The 2009 H1N1 pandemic presents a unique opportunity to study a distinctive health intervention and the influence of sociodemographic factors on health behaviors. By analyzing the social determinants of vaccination, my dissertation illuminates the relationship the social world has on pandemic vaccinations and identifies unique mechanisms linking vaccination behavior to race/ethnicity and gender. This information could prove useful in testing theories on health behavior as well as identifying key factors and groups that may be at risk during a future influenza pandemic.

REFERENCES

Barry, John M. 2005. *The Great Influenza: The Story of the Deadliest Pandemic in History*. New York, NY: Penguin.

Frew, Paula M., Brooke Hixson, Carlos del Rio, Alejandra Esteves-Jaramillo, and Saad B. Omer. 2011. "Acceptance of Pandemic 2009 Influenza A (H1N1) Vaccine in a Minority Population: Determinants and Potential Points of Intervention." *Pediatrics* 127(Supplement 1):S113-S19.

Johnson, Niall PAS, and Juergen Mueller. 2002. "Updating the Accounts: Global Mortality of the 1918-1920 "Spanish" Influenza Pandemic." *Bulletin of the History of Medicine* 76(1):105-15.

Mamelund, Svenn-Erik, Bjørn Haneberg, and Siri Mjaaland. 2016. "A Missed Summer Wave of the 1918–1919 Influenza Pandemic: Evidence from Household Surveys in the United States and Norway." *Open forum infectious diseases* 3(1):ofw040.

Mamelund, Svenn-Erik. 2018. "1918 Pandemic morbidity: The First Wave Hits the Poor, the Second Wave Hits the Rich." *Influenza and Other Respiratory Viruses* 12(3):307-13.

Taubenberger, Jeffery K, and David M Morens. 2006. "1918 Influenza: The Mother of All Pandemics." *Emerging Infectious Diseases* 12(1):15.

US Department of Health and Human Services. 2017. "Pandemic Influenza Plan: 2017 Update." (https://www. cdc.gov/flu/pandemic-resources/pdf/pan-flu-report-2017v2.pdf).

Viboud, Cecile, Mark Miller, Donald R Olson, Michael Osterholm, and Lone Simonsen. 2010. "Preliminary Estimates of Mortality and Years of Life Lost Associated with the 2009 A/H1N1 Pandemic in the US and Comparison with Past Influenza Seasons." *PLoS Currents* (Version 1):2.

CURRICULUM VITA

Andrew E. Burger

(June 2018)

Education

PhD Sociology, Utah State University, Logan UT (*Anticipated August 2018*)

MS Sociology, Utah State University, Logan UT (2012)

BA Sociology, Brigham Young University-Idaho, Rexburg ID (2009)

Current Employment

Professor (unranked), Brigham Young University-Idaho (Fall 2016- Current)
Department of Sociology and Social Work

Peer-Reviewed Research Articles

Burger, Andrew E., Eric N. Reither, Erin Trouth Hofmann, Svenn-Erik Mamelund. (2017). "The influence of Hispanic Ethnicity and Nativity Status on 2009 H1N1 Pandemic Vaccination Uptake in the United States." Journal of Immigrant and Minority Health.

Krueger, Patrick M., Eric N. Reither, Paul E. Peppard, Andrew E. Burger, and Lauren Hale (2015). "Cumulative exposure to short sleep and body mass outcomes: a prospective study." Journal of sleep research.

Burger, Andrew E. and Eric N. Reither (2014). "Monitoring receipt of seasonal influenza vaccines with BRFSS and NHIS data: Challenges and solutions." Vaccine 32(31): 3950-3954.

Masters, R. K., Eric N. Reither, Daniel A. Powers, Y. Claire Yang, Andrew E. Burger, and Bruce G. Link. (2013). "The Impact of Obesity on US Mortality Levels: The Importance of Age and Cohort Factors in Population Estimates." American journal of public health 103(10): 1895-1901.

Burger, Andrew E., Eric N. Reither, David W. Ramos, Sun Young Jeon. (2011). *Racial and Ethnic Disparities in Seasonal Influenza Vaccination among Utah Adults, 2000-2008.* Utah's Health: An Annual Review

Teaching & Research Experience

Research Analyst, The Church of Jesus Christ of Latter-day Saints (2013-2016)
Research Information Division, Correlation Department

- More than 3,000 hours of research experience
- Constructed and administered both electronic and traditional survey questionnaires for a wide variety of topics
- Prepared and analyzed data shown to Church leaders including the Quorum of the Twelve and First Presidency
- Reviewed more than 200+ inter-departmental surveys
- Conducted focus groups and interviews within the United States, Mexico, and Peru

Online Adjunct Faculty, Brigham Young University-Idaho (Fall 2013- Fall 2014)
Department of Sociology and Social Work

- Created online video pod-casts reviewing weekly reading assignments
- Helped students by holding weekly live lectures and office hours
- Received evaluation scores consistently above university average

Athletic Tutor, Utah State University (2013)
Department of Sociology and Social Work

- Tutored students in both Introduction to Sociology and Research Methods

Research Assistant, Utah State University (2013)
Department of Sociology, Social Work, & Anthropology

- Researched literature on sleep deprivation and obesity
- Prepared and cleaned secondary data for use in analysis on link between obesity and mortality

Graduate Instructor, Utah State University (Fall 2012)
Department of Sociology, Social Work, & Anthropology

- Prepared and taught *Introductory Sociology* (SOC 1010), a large enrollment course of 244 students
- Managed and directed team of four staff members including teaching assistant, undergraduate-teaching fellow, Supplemental Instruction leader, and athletic tutor
- Received evaluation scores in the top 20^{th} percentile (4.7/5.0)

Adjunct Faculty, Brigham Young University-Idaho (Spring 2012)
Department of Sociology and Social Work

- Developed and taught two sections of *Introduction to Sociology* (Soc 111)
- Developed and taught new curriculum for *Social Inequalities* (Soc 450)
- Received course evaluation scores above university average

Adjunct Faculty, Brigham Young University-Idaho (Spring 2011)
Department of Sociology and Social Work

- Prepared and taught two sections of *Introduction to Sociology* (Soc 111)
- Developed and taught new curriculum for the upper-division course *Self & Society* (Soc 451)
- Received course evaluation scores above university average

Research Supervisor/Field Technician, Utah State University (2010-2011)
Department of Special Education and Rehabilitation

- Coordinated and led team of three research assistants in administering reading/verbal placement tests among pre-kindergarten children at a local migrant Head Start program
- Conducted reading/verbal placement tests in English and Spanish among pre-kindergarten children

Research Assistant, Utah State University (2009-2011)
Department of Sociology, Social Work, and Anthropology

- Obtained research literature and data regarding aging in rural communities
- Prepared and cleaned secondary data for use in analysis

Presentations at Professional Meetings

2016 Burger, Andrew E., Eric N. Reither, and Erin Hofmann. "The Misconception of Hispanic Homogeneity: H1N1 Vaccination among US-born and Foreign-born Hispanics."

- Poster Presentation at the annual meeting of the Population Association of America. March 31, 2016. Washington D.C.

2013 Burger, Andrew E. "Pandemic Influenza A/H1N1 Vaccination Trends in Utah."

- Oral Presentation at the annual meeting of the Utah Public Health Association. Tele-broadcast to health officials throughout Utah. April 9-10, 2013. Ogden, UT

2013 Burger, Andrew E. "Seasonal Influenza Vaccination Coverage among U.S.-Born and Foreign- Born Hispanics during the 2009 Flu Season."

- Oral Presentation at the annual meeting of the Pacific Sociology Association. March 20-23, 2013. Reno, NV

2012 Burger, Andrew E. and Eric N. Reither. "A New Methodology for Estimating Seasonal Influenza Vaccination Rates in the Behavioral Risk Factor Surveillance System (BRFSS) and the National Health Interview Survey (NHIS)."
- Oral presentation at the annual meeting of the American Public Health Association. October 29-31, 2012. San Francisco, CA

2012 Burger, Andrew E. and Eric N. Reither. "Trends in Seasonal Influenza Vaccination Disparities between US non-Hispanic Whites and Hispanics, 2000-2009".
- Poster presentation at the annual meeting of the Population Association of America. May 3-5, 2012. San Francisco, CA

2012 Masters, Ryan K., Daniel A. Powers, Bruce Link, Eric N. Reither, and Andrew E. Burger. "Obesity and US Adult Mortality: A Bigger Picture of the Growing Threat."
- Oral presentation at the annual meeting of the Population Association of America. May 3-5, 2012 in San Francisco, CA

2011 Burger, Andrew E. "Racial and Ethnic Disparities in Seasonal Influenza Vaccination among US Adults, 2000-2009."
- Poster presented at the 28th Annual Conference of the Behavioral Risk Factor Surveillance System. March 19-23, 2011 in Atlanta, GA

2011 Burger, Andrew E., Eric Reither, David Ramos, Sun Young Jeon. "Racial and Ethnic Disparities in Seasonal Influenza Vaccination among Utah Adults, 2000-2008."
- Research presented at the annual meeting of the Western Social Science Association. April 13-16, 2011 in Salt Lake City, UT

Master's Thesis

Burger, Andrew E. 2011. "Racial and Ethnic Disparities in Seasonal Influenza Vaccination among U.S. Adults, 2000-2009." M.S. thesis, Department of Sociology, Social Work, and Anthropology, Utah State University, Logan, UT. (http://digitalcommons.usu.edu/etd/1081/).

Awards and Recognitions

College of Humanities and Social Sciences Graduate Researcher of the Year, 2015 (https://rgsawards.usu.edu/portfolio-items/andrew-burger/).

Yun and Wendy Kim Graduate Fellow in Population and Development Studies, 2011-2012 (https://youtu.be/CSNbfo7Pvlc).