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Social Determinants of Health and Blood Pressure Control in United States Immigrants

April Zanetta Dawson
Medical University of South Carolina

SOCIAL DETERMINANTS OF HEALTH
AND
BLOOD PRESSURE CONTROL IN UNITED STATES IMMIGRANTS

BY

Aprill Zanetta Dawson

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Chairperson: Chris Gregory, PhD, PT
Committee: Leonard E. Egede, MD, MS
             Rebekah J. Walker, PhD

This dissertation developed a new theory-based conceptual model to understand the impact of

immigrant-specific social determinants of health (SDoH) on health services utilization and

outcomes in immigrants in the context of antecedents, predisposing, enabling, and need factors.

One hundred eighty-one immigrants were recruited from the Greater Milwaukee Area of

Wisconsin. Validated instruments were used to capture antecedents (region of origin,

race/ethnicity, life-course socioeconomic status), predisposing (demographics, subjective social

status, homelessness history, immigration stress, demand of immigration), enabling (healthcare

access, perceived discrimination, perceived stress, health literacy, English proficiency, bicultural

self-efficacy, acculturation), and need (disability, comorbidities, chronic pain) factors. Blood

pressure was measured and recorded for each participant. Regression analyses, confirmatory

factor analysis, structural equation modeling (SEM), and path analysis were used to assess

relationships, create latent variables, identify direct and indirect effects, and to identify direct and

indirect pathways between immigrant-specific SDoH and systolic blood pressure (SBP).

Measured antecedents and predisposing variables were significantly associated with SBP. Five

latent variables were created and found that the need latent variable had a significant direct relationship with SBP. This study validated a conceptual framework for the relationship between immigrant specific SDoH and elucidated pathways linking antecedents, predisposing, enabling, and need factors to SBP.

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INTRODUCTION

<u>Social Determinants of Health</u>

Social determinants of health are factors influenced by where people are born, live, work, and age that are largely responsible for health inequities or unjust and preventable disparities in health status within and between countries (World Health Organization, 2017a; Centers for Disease Control and Prevention, 2017a). The World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) highlight the importance of addressing the social determinants of health by incorporating social determinants into policy efforts, for example inclusion in goals for Healthy People 2020, inclusion in Millennium Development Goals, and a WHO Commission report on using action on social determinants to improve equity (CDC, 2015; WHO, 2017b; Office of Disease Prevention and Health Promotion, 2017). Research has shown that addressing social determinants of health can help achieve health equity, by eliminating systematic disparities due to differences in socioeconomic status and social class (CDC, 2014a; ODPHP, 2017). Social determinants include a broad array of circumstances and experiences that affect the health of individuals, including income, social status, education, physical environment, social support networks, health behaviors, and access to health services (WHO, 2017c; Heiman & Artiga, 2015; ODPHP, 2017). Those with higher income and social status tend to have better health than those living in poverty (WHO, 2017c). Additionally, those with lower education tend to have poorer health, more stress, and less access to healthy physical environments where there is safe water

and clean air in the living and work environments (WHO, 2017c). Finally, access to health services affects health outcomes through the utilization of services that prevent and treat diseases (WHO, 2017c).

In recognition of their importance, several governmental and non-governmental organizations in the US are pushing for increased funding to address social determinants that are essential to improving the health of individuals through the revitalization of low-income neighborhoods and increasing the breadth of the mission of health care providers to extend beyond medical treatment (Marmot & Allen, 2014). Based on a review of the literature, the World Health Organization outlined a framework for understanding how the distribution of money, power and resources at local, national, and international levels effect health behavior, risks, and outcomes (WHO, 2017a; CDC, 2017b). Social, economic and political mechanisms or structural determinants influence socioeconomic positions, where populations are stratified according to income, education, occupation, gender, race/ethnicity and other factors (WHO, 2010). This stratification or class differentiation dictates more intermediate determinants of health status such as living and working conditions, behaviors, psychosocial factors, and access to healthcare (WHO, 2010). As one's exposure to health-compromising conditions is greatly influenced by social status or class, social determinants explain why some individuals are healthier than others. (WHO, 2010). Health is also determined by access to social and economic opportunities and access to resources and support available in our neighborhoods and communities (Venkataramani et al., 2016; Zimmerman et al., 2015). While information and policies suggest the importance of social determinants, national efforts to act are lacking due to limited information on how to prioritize and focus action.

Immigrant Health

There were approximately 244 million international migrants, defined as people who live in a country other than their country of birth, in the world in 2015 (United Nations, 2016). The International Organization for Migration acknowledged the importance of addressing migration as a social determinant of health following the 62nd World Health Assembly held in 2009 (International Organization for Migration, 2017). The lives of immigrants are influenced by social determinants experienced in their countries of birth as well as by new social determinants experienced in the country of immigration (Castañeda et al., 2015). The United States Department of Homeland Security provides multiple categories and definitions of immigrants. Categories provided include Lawful Permanent Residents (LPR), Refugees and Asylees, Nonimmigrants, and Naturalized citizens (United States Department of Homeland Security, 2016). Immigrants for purpose of this dissertation are defined as anyone born outside of the continental United States and its territories, and includes all US Department of Homeland Security categorizations outlined above.

Data from the 2014 US Census Bureau show that 42.4 million documented and undocumented immigrants live in the US, making up 13.3% of the nation's population (Camarota & Zeigler, 2016). During the years 2010 – 2014, 87% of total US population growth, an addition of 8.3 million residents, was due to new immigration and births to immigrants (Camarota & Zeigler, 2016). In 2015, 1.38 million foreign-born individuals moved to the US, slightly more than the 1.36 million that moved in 2014 (Zong & Batalova, 2017). Latin America accounts for about 52% of immigrants overall. Between the years 2010 – 2014 Mexico, India, China, the Philippines, Cuba, the Dominican Republic, and Vietnam were the top home countries of immigrants (Camarota & Zeigler, 2016; American Immigration Council, 2017; Zong & Batalova ,2017). Also, during this

time, some countries had an increased percentage of immigrants in the US including: Saudi Arabia (increase of 93%), Bangladesh (increase of 37%), Iraq (increase of 36%), Egypt (increase of 25%), and Pakistan, India, and Ethiopia (each had an increase of 24%) (Camarota & Zeigler, 2016). The foreign-born population in 2014 more than doubled since 1990, tripled since 1980, and quadrupled since 1970 when it was 9.6 million (Camarota & Zeigler, 2016). The immigrant population has increased 22.6 million since 1990 which was more than double the size of the foreign-born population in 1970 or 1900 (Camarota & Zeigler, 2016). Census bureau projections predict that foreign-born individuals will make up 14.8% of the US population, the highest percentage in US history (Camarota & Zeigler, 2016).

In 2015 about 51% of immigrants were female, and the median age was 43.9 years compared to 36 years old for native born (Zong & Batalova, 2017). Immigrant men were found to have higher rates of work than native-born men, 82% and 73% respectively (Camarota & Zeigler, 2016). Twenty-eight percent of immigrants ages 25 – 65 did not complete high school compared to 8% of native-born; where 30% of immigrants compared to 32% of native-born had at least a bachelor's degree (Camarota & Zeigler, 2016). In 2014, 49% of maids, 47% of taxi drivers and chauffeurs, 33% of butchers, and 35% of construction laborers were foreign-born (Camarota & Zeigler, 2016).

Immigrants are more likely to work low-paying jobs, live in poverty, and lack health insurance because a large percentage of them have little education (Camarota & Zeigler, 2016). Twenty-one percent of immigrants and their US-born children lived in poverty in 2014, compared to 13% of native-born individuals. Immigrants and their children account for about 25% of all people living in poverty (Camarota & Zeigler,

2016). In 2014, 18% of immigrants and their US-born children lacked health insurance compared to 9% of native-born and their children (Camarota & Zeigler, 2016).

Prior work on the health of immigrants has identified the "healthy immigrant effect", where immigrants who arrive to the new country are thought to have better health status than individuals in similar socioeconomic status native to the country (Kennedy et al., 2015; Akresh & Frank, 2008; Siddiqi et al., 2013). One possible explanation of this phenomenon is that the process of immigration is a selective process in which immigrants who are healthier, have less disease and are wealthier will be able to endure the stressful process of migration (Lu et al., 2017; Kennedy et al., 2015). In addition to migration being a stressful and, in some cases, physically grueling process, it is also an expensive process (Kennedy et al., 2015). As the cost of migration rises, the likelihood of receiving immigrants who are from the upper class or better off financially will increase thereby increasing the selective nature of immigrants and increasing the likelihood of receiving individuals who are not representative of the general population in the home-country (Kennedy et al., 2015).

Over time it is believed that immigrant health declines the longer one resides in the host-country. One possible explanation for this is that chronic conditions may go undiagnosed due to social, cultural, or language barriers to accessing and receiving health care (McDonald & Kennedy, 2004). Additionally, immigrants may have a lower mortality rate due to the "salmon bias". This concept proposes that immigrants may return to their home country if they become ill and are likely to die (Abraído-Lanza et al., 2005).

Immigrants face specific factors affecting health outcomes that many native-born individuals do not have to face (Rosenthal, 2018). Immigrant-specific factors include

cultural beliefs, disease knowledge, access to care, acculturation, limited English proficiency, fear of deportation, stress associated with migration, and socioeconomic factors (Rosenthal, 2018; Luque et al., 2018; Herbert-Beirne et al., 2018). Some cultures report only seeing a health care provider when they are sick and chronic diseases such as diabetes being highly stigmatized to the point that it negatively influences self-care practices (Kindarara et al., 2017; Smith-Miller et al., 2017). Other cultures attribute illness to spiritual, supernatural, or social causes rather than a physiological cause (Vaughn et al., 2009). Socioeconomic factors affecting immigrants' ability to seek care include the inability to pay, lack of health insurance, and being unable to take time off of work (Luque et al., 2018). Differences in health status have been noted between immigrant groups (Young & Pebley, 2017). As a result of the complex nature of immigration, research into the social determinants of health that influence immigrants is warranted.

Social Determinants of Health and Immigrant Health Outcomes

Burden of Disease in Immigrants – Hypertension and Cardiovascular Disease

About 75 million or 29% of adults in the US have hypertension, and the disease was estimated to be $48.6 billion in direct and indirect costs (CDC, 2016b; Yoon et al., 2015; Mozaffarian et al., 2016). Foreign-born immigrants have been found to have higher prevalence of hypertension compared to US-born Whites, with individuals who speak a language other than English having almost twice the odds of having hypertension (Yi et al., 2014; Bidulescu et al., 2015). Additionally, results from a metanalysis conducted by Steffen et al found that more acculturated individuals had higher systolic blood pressure than less acculturated individuals (Steffen et al., 2006). Foreign-born individuals are

significantly more likely to be unaware of cardiovascular disease (CVD) risk factors such as hypertension and being overweight than those who are US-born (Langellier et al., 2012; Shin et al., 2018). This may be due to foreign-born being less-likely to receive preventive health care services than other populations (Rodriguez et al., 2009; Wallace et al., 2007; Dubard et al., 2008). Immigrants born in the Indian subcontinent were found to have similar risk of hospitalization for heart disease, diabetes, and stroke as their native-born counterparts, however they were found to be at a higher risk than are immigrants from other countries (Muennig et al., 2004).

Longer residence in the US is associated with increased odds of having multiple CVD risk factors including obesity, hyperlipidemia, and cigarette smoking (Koya et al., 2007; Shin et al., 2018); and is associated with higher prevalence of stroke and high blood pressure (Salinas et al., 2014). However, some immigrants have been found to have more cardiac risk factors including higher systolic blood pressure, more prior coronary arteriography and myocardial infarction, and coronary artery bypass graft surgery than individuals born in the US (Fridman et al., 2006). Immigrants from the Former Soviet Union (FSU) had higher systolic blood pressure than US born even though they had higher usage rate of beta-blockers and similar usage rate of other medications used to treat high blood pressure (Fridman et al., 2006). It was also found that more than half of FSU immigrants preferred complementary and alternative therapies over American treatments (Fridman et al., 2006). It has been found that immigrants in the US are at a higher risk for myocardial infarction and stroke than US-born (Dassanayake et al., 2011).

Contribution of Social Determinants of Health

Research has found that social determinants of health and health outcomes vary across ethnic groups. For example, in African Americans, a higher level of education was associated with a lower likelihood of hypertension and diabetes (Commodore-Mensah et al., 2018a). However, among African immigrants, having health insurance was associated with higher odds of hypertension; and having health insurance and a lower level of education was associated with higher odds of diabetes (Commodore-Mensah et al., 2018a). Additionally, among Afro-Caribbeans higher SES was associated with lower odds of hypertension (Commodore-Mensah et al., 2018a).

Role of Antecedents, Predisposing, Enabling, and Need Factors

Health services researchers continuously use the model developed by Aday and Andersen (Aday &Andersen, 1975) to group determinants of health service utilization into predisposing factors such as age, sex, marital status, education; resources or enabling factors such as insurance, employment, income; and need factors such as number of chronic diseases, physical status, and self-rated health (Wells et al., 1989; Lara et al., 2005). Studies have successfully applied the Andersen model of health services utilization with some immigrant groups (Markides et al., 1985). Studies that controlled for predisposing, enabling, and need factors found conflicting results. Some studies found that acculturation was not associated with increased physician visits, while others found differences in use depending on level of acculturation (Lara et al., 2005; Wells et al., 1989). One study by Markides et al. found that need factors were more likely to affect utilization; however, predisposing variables had little effect on physician utilization in a foreign-born sample (Markides et al., 1985). Need factors such as comorbidities, chronic pain, disabilities, obesity, and other mutable variables have been found to contribute

significantly to the relationship with health outcomes especially hypertension and CVD (Noh et al., 2016; Ibekwe, 2015; Bruehl et al., 2005; Stevens et al., 2014).

Impact of Acculturation

Acculturation, defined as a multidimensional process in which the practices, values, and identifications adopted from the country of origin merge with those of the receiving country (Schwartz et al., 2010; Lara et al., 2005; Wells et al., 1989), has been found to be associated with negative health-related behaviors and outcomes such as: illicit drug use, alcohol intake, smoking, poor diet, and poor birth outcomes (Lara et al., 2005; Abraído-Lanza et al., 2005). Individuals who were more acculturated tend to have a more American-style diet, eat less fruits and vegetables, more fast food and sugar than those who are less acculturated (Ayala et al., 2008). Some immigrants realize that there are negative effects associated with adopting an Americanized diet, however, barriers exist to accessing native foods while living in the host country (Kindarara et al., 2017). It has been found that longer residence in the US is associated with increased prevalence of diabetes, possibly due to increases in obesity and caloric intake (Ahmed et al., 2009). The use of the English language among Hispanics was found to be associated with an increased risk for hypertension in men and having ever smoked (Salinas et al., 2011).

Acculturation also has positive impacts including higher rates of insurance coverage, greater access to health care, and fewer barriers to care (Lara et al., 2005). Acculturation was also found to be associated with greater likelihood of engaging in exercise (Abraído-Lanza et al., 2005).

Immigrants are faced with fewer options for adopting healthy behaviors and accessing health promoting services due to immigration status, language barriers, cultural

barriers, structural barriers, and socioeconomic status (Castañeda et al., 2015). Finally, immigrants develop a sedentary lifestyle, stress due to immigration-related issues, and report higher levels of food insecurity than US-born individuals (Kindarara et al., 2017; Young & Pebley, 2017; Walsemann et al., 2017). This combination of factors in addition to barriers to accessing and receiving health care put immigrants at increased risk of negative health outcomes (Young & Pebley, 2017).

<u>Current Gaps in Knowledge</u>

While social determinants may explain some of the changes seen over time in the health of immigrants, little research has been done. Many data collection instruments and surveillance systems do not collect data on immigration, race, ethnicity, primary language, or country of birth (Rodriguez-Lainz et al., 2018). Without this data, public health and health care workers are limited in the ability to identify disparities and areas of need in immigrant populations (Rodriguez-Lainz et al., 2018). Immigration policies and increasing rates of deportation in the United States, increasing stress, and decreasing access to health care have resulted in negative impacts on health and well-being for this population (Castañeda et al., 2015; Muñoz et al., 2015; Hacker et al., 2012; Ojeda et al., 2011). More research is needed to understand the effect of social determinants of health on blood pressure control. Additionally, there is no validated conceptual model to explain the relationship between social determinants of health and blood pressure control in immigrants. Finally, while prior health services models identify antecedents, predisposing, enabling and need factors as drivers of health utilization and outcomes, these models do not adequately account for social determinants of health or incorporate immigrant specific factors.

<u>Study Rationale</u>

This study is of paramount importance given the increase in immigration worldwide and addresses many current gaps in the literature surrounding social determinants of health and immigrant health outcomes. This study examined in depth the relationship between social determinants of health and blood pressure; and was able to determine the contribution of antecedents, predisposing, enabling, and need factors on blood pressure in immigrants. New latent variables with greater explanatory power were identified; and a new conceptual model that is evidence-based was tested and will ultimately serve as the foundation for the development of future interventions.

<u>Study Methodology</u>

Four main statistical techniques were used to address the gaps in knowledge and answer the study question: Regression, Confirmatory Factor Analysis, Path Analysis, and Structural Equation Modeling. Regression is generally used to evaluate the relationship of one or more independent variables with a single dependent variable (Kleinbaum et al., 2014). This statistical method is a tool that allows for the characterization of the relationship between variables through the determination of the extent, direction, and strength of association (Kleinbaum et al., 2014). While regression is a commonly used statistical method, it has limitations preventing it from being a standalone method able to address the research question and aims (Kleinbaum et al., 2014). Due to inconsistencies in recommendations of best regression methods, three approaches were used to model the relationship between antecedents, predisposing, enabling and need factors, and blood

pressure: sequential modeling, stepwise regression with backward selection, and all possible subsets or best subsets regression.

Factor analysis describes a set of statistical procedures that were created to determine the number of constructs assessed by a set of measures (Fabrigar et al., 2012). Confirmatory factor analysis (CFA) is used when predictions are made regarding the number of common factors and which measures will be influenced by those factors (Fabrigar et al., 2012). CFA models must be identified before they can be analyzed (Kline, 2016).

Path analysis, a logical extension of multiple linear regression, is a method for studying the direct and indirect effect of variables (Schumacker & Lomax, 2010). It uses models involving multiple observed variables and can accommodate any number of independent and dependent variables as well as any number of equations (Schumacker & Lomax, 2010). Path analysis analyzes several multiple regression equations using observed variables (Schumacker & Lomax, 2010).

Structural equation modeling (SEM) is a combination of multiple regression, CFA and path analysis that allows incorporation of multiple independent and dependent variables in a hypothesized casual relationship to produce numeric estimates for hypothesized effects (Schrieber et al., 2006; Kline, 2016). SEM is able to validate the pattern of observed variables for latent constructs in the hypothesized model; providing insight into both direct and indirect effects (Schreiber et al., 2006). Unlike path analysis, SEM is able to test relationships between multiple observed and latent variables (Schrieber et al., 2006; Kline, 2016). This study will use a combination of multiple linear regression, CFA, path analysis and SEM statistical methodologies to investigate the

relationship between latent and measured constructs on multiple measures of immigrant health.

Research Question and Aims

The overarching goal of the study was to examine the relationship between social determinants of health and systolic blood pressure among immigrants in the United States using a conceptual model that includes previously validated measures of antecedents, predisposing, enabling, and need factors. Four aims were used to address the goal:

Aim 1: To examine the relationship between immigrant specific social determinants of health and blood pressure control in US immigrant adults using regression analysis.

Aim 2: To use a theory-based model to create latent variables that define immigrant specific social determinants of health and use confirmatory factor analysis and structural equation modeling to test theoretical validity and their relationship with systolic blood pressure in US immigrant adults.

Aim 3: To identify direct and indirect pathways of the relationship between latent variables for immigrant specific social determinants and blood pressure control among US immigrant adults using structural equation modeling.

Aim 4: To validate a theory-based conceptual model that incorporates indicator variables for immigrant specific social determinants classified as antecedent, predisposing, enabling, and need factors and assess their relationship with blood pressure using path analysis.

<div align="center">**REVIEW OF THE LITERATURE**</div>

<u>Social Determinants of Health and Immigrant Health</u>

Social determinants of health include nonmedical factors that influence health such as attitudes, beliefs, culture, behaviors, health knowledge, employment, place of birth, place of residence, and other factors that may directly or indirectly have an effect on health (Braveman et al., 2011; WHO, 2018a; CDC, 2014a). Immigrants are faced with specific determinants that do not affect the native-born population (Yang & Hwang, 2016). Factors such as stress associated with migration, stress due to fear of deportation, employment status, access to food and social services, and learning how to navigate the health system in a new country where one may not speak or understand the language bring to light a different set of determinants specific to the foreign-born population (Castañeda et al., 2015; Yang & Hwang, 2016). While it has been thought that immigrants have better health than the native-born population, research has shown that this "healthy migrant" effect wanes the longer one resides in the United States (Kuerban, 2016; Delavari et al., 2013). This phenomenon gives rise to the need to understand factors specific to immigrants and the relationship between those factors and health outcomes in the ever-growing adult immigrant population.

Social Determinants of Health and WHO Model

The Commission on Social Determinants of Health (CSDH) was established by the World Health Organization (WHO) with the goal of understanding how societies, institutions, and societal norms affect population health (WHO, 2010). The CSDH conceptual framework illustrates how social, economic, and political factors lead

to a set of economic positions where people are then stratified by income, education, occupation, gender, race/ethnicity and other factors (WHO, 2010). It is these socioeconomic positions that shape determinants of health that are reflective of one's social class or hierarchy (WHO, 2010). Depending on one's social status, experiences in differences of exposure and vulnerability to health-compromising conditions vary (WHO, 2010). Morbidity can then cycle back to one's social position by reducing income or compromising employment (WHO, 2010).

Figure 1. CSDH Conceptual Framework
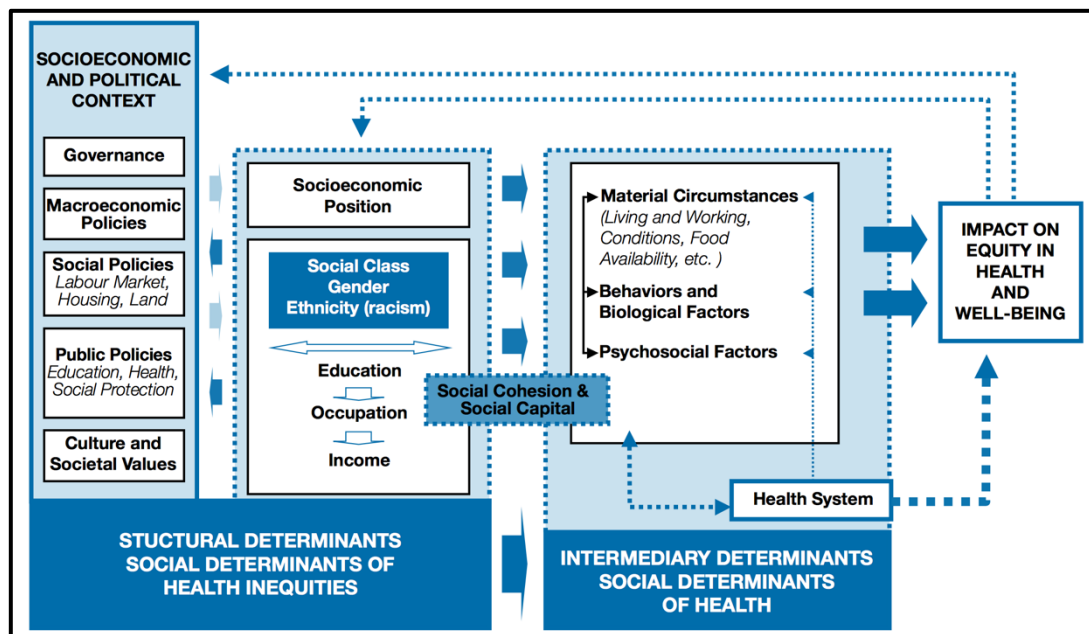
The CSDH framework is broken into two main components, structural determinants and intermediary determinants of social determinants of health as illustrated in figure 1 (WHO, 2010). Structural mechanisms are those that create stratification and social class divisions in society and that define socioeconomic position within hierarchies of power, prestige and access to resources (WHO, 2010). Key structural stratifiers are income, education, occupation, social class, gender, and race/ethnicity (WHO, 2010). Structural determinants of health are the combination of the socioeconomic and political

context, structural mechanisms, and the resulting socioeconomic position of individuals (WHO, 2010). Factors such as poor and unequal living conditions are the result of structural conditions that make up the way societies are organized resulting in limited social programs, and inequitable economic opportunities (WHO, 2008). Intermediary determinants of health are defined by four main categories that include: material circumstances, psychosocial circumstances, behavioral and biological factors, and the health system (WHO, 2010). Material circumstances include housing, neighborhood quality, the physical work environment, and the ability to purchase healthy food and warm clothing as indicators of consumption potential (WHO, 2010; Marmot, 2004). Psychosocial circumstances include psychosocial stressors, stressful living circumstances and relationships, and the presence or absence of social support and coping styles (WHO, 2010). Behavioral and biological factors include nutrition, physical activity, tobacco consumption, alcohol consumption, and genetic factors (WHO, 2010).

The health system is an important determinant in this model as it addresses the issue of access and allows for the incorporation of differences in exposure and vulnerability or need for services. The health system plays an important role in mediating the negative effects of morbidity in populations (WHO, 2010). The CSDH conceptual framework highlights the need for interventions and policies to be developed that not only address intermediary determinants, but those that also address the social mechanisms that systematically produce an inequitable distribution of the determinants of health among population groups (WHO, 2010). Social determinants of health affect factors that are associated with health outcomes (CDC, 2014a).

Pros of this model are that it is well-adapted and commonly used when discussing social determinants of health, and it includes policies and the health system as key

components of health outcomes. Frequently, researchers focus solely on health behaviors and omit these two important factors. A con to using this model is that it's not specific to immigrant health, so there are some areas that should be applied with caution when working with an immigrant population. For example, well-trained and educated immigrants with professional titles in their home country may be forced to accept jobs outside of their professional fields such as those in the service industry because the titles and licenses are not recognized in the US (Jamil et al., 2012). Additionally, some immigrants are not able to or are delayed in being able to benefit from public policies affecting access to healthcare (Edward, 2014; Ku & Matani, 2001).

Conceptual Framework

Health Services Research Model (Aday & Andersen)

Aday and Andersen have published multiple models to show the relationship between health care services utilization and access to health services. These models serve as the foundation of health services research. The original model that was developed and published by Andersen in 1968 was a three-stage model that used predisposing, enabling, and need components to explain the varying degrees of health care services utilization (figure 2) (Andersen, 1968).

Figure 2. Andersen Model (1968)
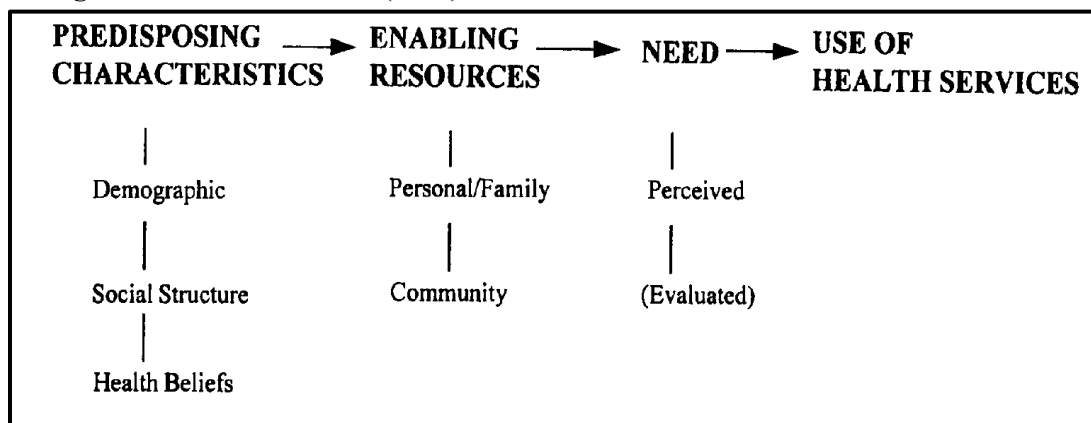
This original model was revised to address concerns that had been expressed by policy makers surrounding the idea that access to the medical system needed to be improved (Aday & Andersen, 1974). The model that was published by Aday and Andersen in 1974 included health policy, characteristics of the health care delivery system, characteristics of the population at risk (predisposing, enabling, need factors), utilization of health care services, and consumer satisfaction (figure 3) (Aday & Andersen, 1974).

Figure 3. Aday & Andersen Model (1974)

Framework for the study of access.
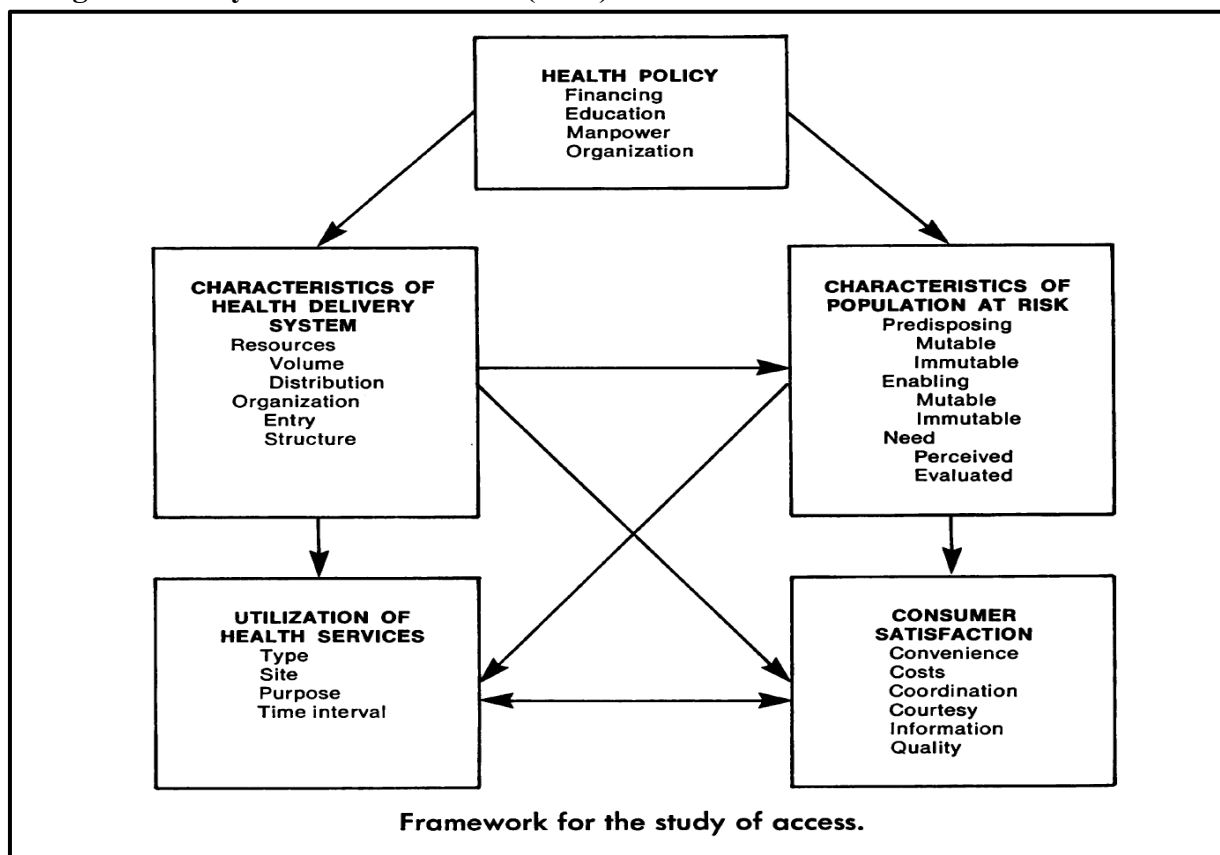
The third model proposed by Aday and Andersen was published in 1981 and included the addition of health status outcomes (figure 4) (Aday &Andersen, 1981).

Figure 4. Aday and Andersen Model (1981)

PRIMARY DETERMINANTS → HEALTH BEHAVIOR → HEALTH OUTCOMES
OF HEALTH BEHAVIOR

Population Characteristics   Personal Health   Perceived Health
                                  Practices   Status

Health Care System   Use of Health   Evaluated Health
                                  Services   Status

External Environment   Consumer
                                                           Satisfaction
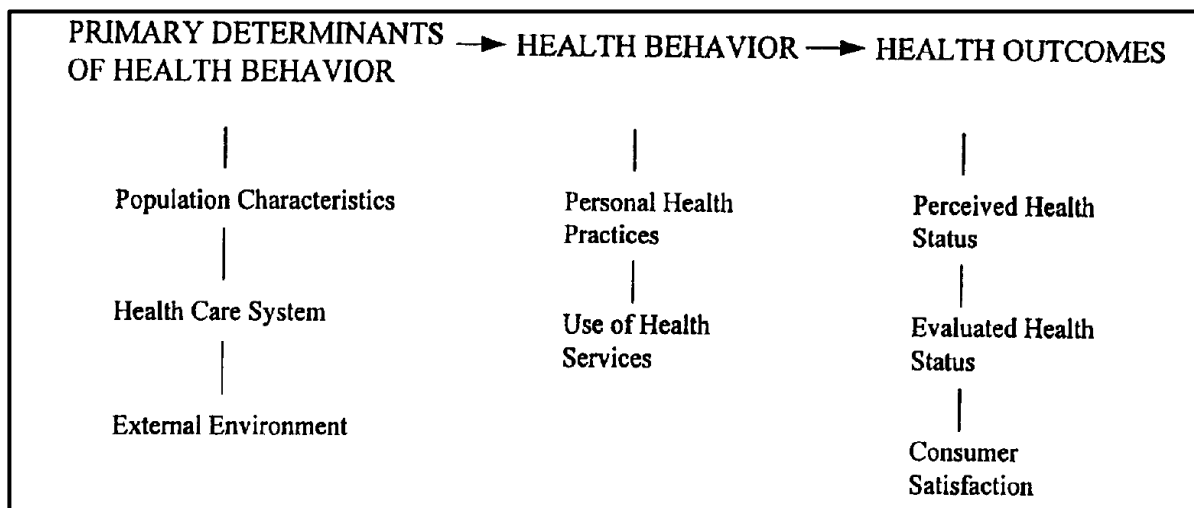
Lastly, the final model published by Andersen in 1995 serves as the foundation for much

of health services research. This model shows that there are multiple influences on health

services utilization and health status. The model includes predisposing factors (age, sex,

race, religion, etc.); enabling factors (income, insurance, etc.); and need factors (level of

illness; health behaviors; and outcomes) (figure 5) (Andersen, 1995).

Figure 5. Andersen Model (1995)

ENVIRONMENT   POPULATION CHARACTERISTICS   HEALTH BEHAVIOR   OUTCOMES

Health Care System / External Environment → Predisposing Characteristics → Enabling Resources → Need → Personal Health Practices / Use of Health Services → Perceived Health Status / Evaluated Health Status / Consumer Satisfaction
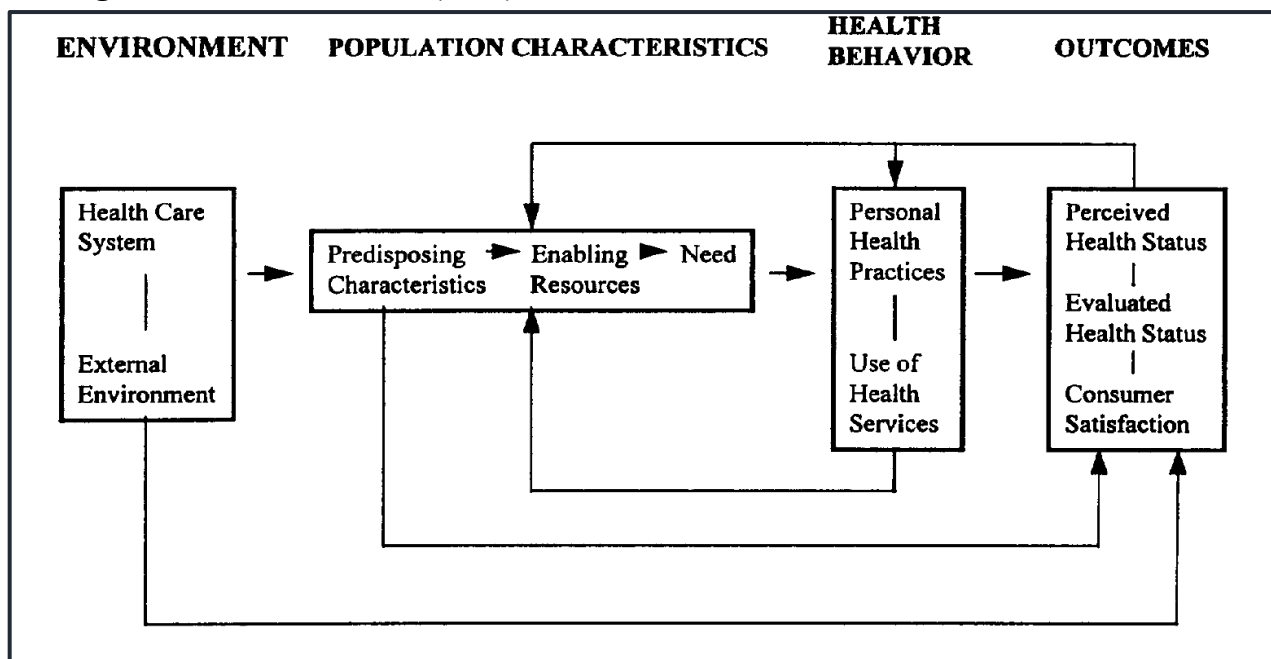
While this model is useful and can be used for considering social determinants of health and health outcomes there are immigrant specific factors that are not accounted for in the model's current state.

Coyle & Battle Model

Donabedian first proposed examining structure, process, and outcomes in terms of defining the quality of care received (Donabedian, 1988). This was based on the idea that having good structure increases the odds of having good processes, which increases the odds of having good health outcomes (Donabedian, 1988). The Coyle and Battles model published in 1999 provides us with a means of categorizing factors that affect health services utilization into antecedents, structures, processes, and outcomes (figure 6) (Coyle & Battles, 1999).

Figure 6. Coyle and Battles Model

Antecedents	Structure	Process	Outcome
Environment	System characteristics	Technical style	Clinical end points
Cultural	Provider characteristics	Interpersonal style	Functional status
Social	Patient		General well-being
Political	characteristics		Satisfaction with care
Personal			
Physical			
Health professions			
Patient personal characteristics			

While the Andersen model included the environment, it was in terms of the health care system and external environment. Coyle and Battles introduces the environment in terms of varying cultural, social, political, personal, physical, and health professions

characteristics broadening the scope of the environmental components and the role that they may contribute to health services utilization and access (Coyle & Battles, 1999). Coyle and Battles also opted to consider patient personal characteristics as antecedents (Coyle & Battles, 1999). This model highlights the idea of antecedents having an effect on the structure, process, and outcomes of medical care meaning that they may have the largest effect on care (Coyle & Battles, 1999). Coyle and Battles describe the structure of medical care as all components of the setting in which medical care occurs, including the organization, personnel, financial incentives, provider beliefs and attitudes, and patient diagnoses and comorbidities to name a few (Coyle & Battles, 1999). While this model includes factors contributing to the quality of care and introduces us to the importance of antecedents it still does not incorporate concepts specific to immigrants that contribute to immigrant health and health outcomes.

Yang & Hwang Model

The Yang & Hwang model allows for the inclusion of components that are specific to immigrant populations contributing to the utilization of health services (Yang & Hwang, 2016). Yang and Hwang not only introduced immigrant specific factors to what resembles the Andersen 1995 model, but also included the addition of macrostructural and contextual factors in the model (figure 7) (Yang & Hwang, 2016). These authors postulated that immigrant health service utilization can be explained by macrostructural/contextual, predisposing, resources or enabling, and need factors (Yang & Hwang, 2016). Examples of immigrant specific predisposing factors include immigration status, assimilation, and ethnic culture (Yang & Hwang, 2016).

Figure 7. Yang and Hwang Model
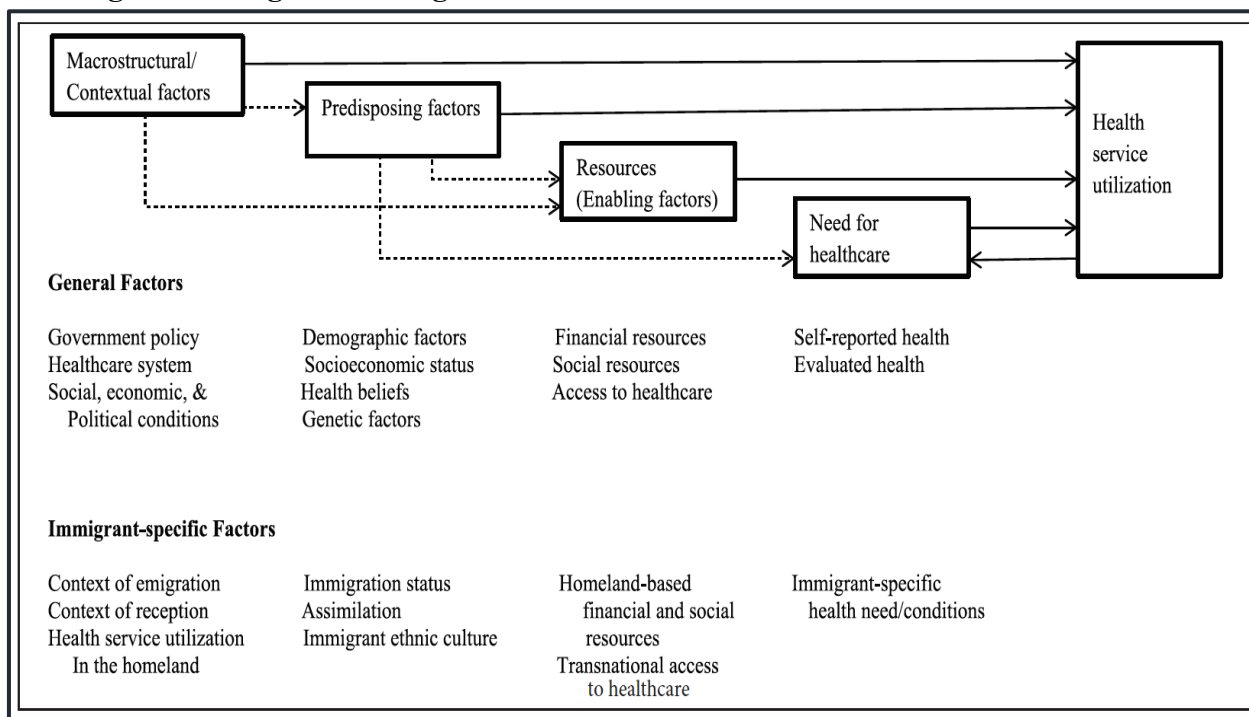
The literature supports the idea that immigration status, citizenship, culture, and

assimilation all contribute to immigrant health outcomes (Young & Pebley, 2017; Smith-

Miller et al., 2017; Akresh, 2007; Antecol & Bedard, 2006). Immigrant specific enabling

factors or resources include having financial and other resources in the home country

(Yang & Hwang, 2016). Some immigrants are able to bring those resources with them to

the new country supplementing their new income, while others are able to access health

services in the home country, choose traditional medicine, or utilize health services in the

new country offering them more flexibility and choices than a native-born individual

would be able to access (Yang & Hwang, 2016). Immigrant specific need factors vary

depending on region or country of origin and are based upon diseases and conditions that

are more prevalent in the country of origin than in the US. Some examples include

tuberculosis, asthma, hepatitis, liver and lung cancers due to the high prevalence of those

diseases in the home country and risk behaviors; and vaccine preventable infections due to lower rates of vaccination in some countries outside of the US (Yang & Hwang, 2016; Dhooper, 2003; Chen & Hawks, 1995; White & Atmar, 2002). Additionally, immigrants may have different healthcare needs as they are traditionally known to be healthier than the native population due to the natural selection of healthier individuals for migration (Yang & Hwang, 2016). However, over time the needs may change as immigrants start to take on health profiles similar to those of native-born individuals (Yang & Hwang, 2016).

Dawson & Egede Model

While the Yang and Hwang model take into account immigrant specific factors, the model omits health outcomes as seen in the Coyle and Battles and the Andersen models. Due to the limitations of existing models, it is necessary to develop and validate a new model that examines the relationship between antecedents, predisposing, enabling and need factors, and health outcomes in immigrant populations under the context of social determinants of health. The proposed Dawson & Egede model (figure 8) fills the gap of providing a health services research model that is specific to foreign-born population and takes into account structural and intermediary determinants of health while understanding the relationship with health outcomes.

Figure 8. Dawson and Egede Theory-Based Conceptual Model for Immigrant Specific Social Determinants of Health Outcomes

Antecedents	Predisposing Factors	Enabling Factors (Resources)	Need for Healthcare Factors	Outcomes

• Region/Country of Origin
• Ethnicity/Race
• Life-course Socioeconomic Status
	• Demographic Factors
	  • Age
	  • Sex
	  • Marital Status
	  • Education
	  • Employment
	  • Household Income
	• Subjective Social Status
	• Homelessness History
	• Immigration Stress
	• Demand of immigration
		• Healthcare Access
		• Insurance
		• Perceived Discrimination
		• Perceived Stress
		• Health Literacy
		• English Proficiency
		• Bicultural Self-Efficacy
		• Acculturation
			• Health & Disability
			• Health Status
			• Chronic Conditions
			• Chronic Pain
				• Clinical End Points
				  • Systolic Blood Pressure
				• Quality of Life
				• Satisfaction with Care
				• Patient-centered Care

Social Determinants of Health and Hypertension in United States Immigrants

Hypertension is a highly prevalent chronic condition and risk factor for cardiovascular disease affecting about 33% of the adult US population (CDC, 2016b). In addition to being prevalent, hypertension is costly with expenditures totaling over $130 billion annually in the US (Kirkland et al., 2018). Differences in hypertension between the US-born and immigrant populations have been noted. New immigrants, those who have been in the US for less than ten years often have lower blood pressure than those who have resided in the country for a longer period of time (Commodore-Mensah et al., 2016; Salinas et al., 2014). Reasons for these differences have been attributed to genetic, biological, and lifestyle factors (Brown et al., 2017; Zallman et al., 2013; Fang et al., 2018; Hall & Cuellar, 2016; Yi et al., 2016; Bamimore et al., 2012). However, social determinants are believed to have greater explanatory power for hypertension and need to

be studied in detail to gain an understanding of how these factors influence this condition in immigrants residing in the US (Poston et al., 2001).

While there is extensive literature on social determinants of health and their influence on chronic conditions such as hypertension, there is little understanding of how immigrant-specific determinants influence blood pressure control in adult US immigrants. Research needs to be done to increase understanding of the key drivers of hypertension and the mechanism by which immigrant-specific determinants influence blood pressure control. Using a theory-based conceptual model to understand these factors will provide researchers with information needed to identify intervention targets to reduce blood pressure in immigrants.

Social Determinants of Health & Hypertension Using the Dawson & Egede Model

Antecedents

Region/Country of Origin

Immigrants in the United States face numerous barriers to accessing health care and receiving necessary health services. Some of the barriers include cultural beliefs, lack of disease knowledge, lack of social support due to leaving their country of origin, poorer health and lack of access due to being uninsured or inadequately insured, limited cultural sensitivity, lack of transportation, health illiteracy, and limited English proficiency (LEP) (Tapales et al., 2018; Velasco-Mondragon et al., 2016; Raghavan, 2018; Shaw et al., 2009). Some cultural beliefs that act as barriers to immigrants receiving care include the practice of seeing the doctor only when they are sick and not for preventative measures or to control disease (Kindarara et al., 2017; Shaw et al., 2009). Immigrants have been

known to turn to family members for sources of emotional support (Kindarara et al.,

2017). Family members have been able to assist by reminding individuals who are sick to

take their medications, providing comfort, food, and transportation to medical

appointments (Kindarara et al., 2017). However, some groups are less likely to have

social support and are unlikely to participate in group-based interventions because of not

wanting to disclose information about their disease (Smith-Miller et al., 2017).

Ethnicity/Race

Race and ethnicity categories have been labeled as social-political constructs that

identify the combination of political, historical, legal, and cultural factors among groups;

and do not represent biological distinctions (Institute of Medicine, 2009). Race and

ethnicity have been identified as important factors when considering health outcomes and

access to care (IOM, 2009). Ethnicity/Race categories are defined according to the

Institute of Medicine (IOM) Office of Management and Budget (OMB) and US Census

Bureau definitions for Hispanic or Latino, American Indian or Alaska Native, Black or

African American, Native Hawaiian or Other Pacific Islander, White, and Some Other

Race (AHRQ) (IOM, 2009).

The literature shows that Latinos with lower income, less education, and those

who reported a decline in their financial situation over the past year had poorer health

than Latinos on the opposite end of this spectrum (Guzman et al., 2018). It has also been

shown that race strongly predicts health disparities for immigrants (Danso, 2016). Non-

Hispanic Black (NHB), Asian, and Hispanic immigrants are less likely to report good or

excellent health compared to Non-Hispanic White (NHW) individuals (Danso, 2016).

Undocumented Latino immigrants have been found to experience greater barriers to

health care and more stress related to anti-immigrant environments and enforcements in daily life than documented immigrants or US-born Latinos (Young & Pebley, 2017).

<u>Life-course Socioeconomic Status (SES)</u>

Life-course socioeconomic status (SES) is the change in social mobility from parent to the individual; this change is based on maternal and paternal SES in relation to individual SES (Akinyemiju et al., 2016). Immigrants are exposed to factors during the migration process that the majority or native born do not have to face. Some immigrants experience these factors during childhood and in some cases while in utero (Spallek et al., 2011). By using a life-course perspective, one can gain greater understanding of the health status of immigrants and the different factors faced contributing to their health status and outcomes (Spallek et al., 2011). Spallek et al. categorizes periods of exposure to potential health altering factors by the period prior to migration, the migration process, and the post migration period (Spallek et al., 2011). During the period prior to migration, immigrants may be exposed to factors or diseases endemic to their home country which may not be faced by native-born individuals of the new country (Spallek et al., 2011). Immigrants are frequently exposed to stress associated with the migration process which may lead to increased risks of mental health conditions or cardiovascular disease (Spallek et al., 2011). Finally, the post migration period may be a time when immigrants are forced to accept low-wages, live in poor conditions, or be unable to find health care when needed (Spallek et al., 2011). Individuals who arrive earlier in life spend a longer period of time in the new country, are more likely to have similar experiences to those of the native-born population and therefore in later life will have outcomes that are closer to those of the native-born population than that of individuals of the same age in their home-country (Treas, 2014).

Predisposing Factors

<u>Demographics</u>

Demographic variables including age, sex, marital status, education, employment, and income are important factors to consider when assessing healthcare utilization and health outcomes. As expected, higher educational level is shown to be associated with better health among immigrants (Danso, 2016). Immigrants with higher incomes and those who report living in a safe neighborhood experience better health than those who do not; supporting the idea that both structural and intermediary determinants are contributing factors to immigrant health (Danso, 2016).

<u>Subjective Social Status</u>

Subjective social status (SSS) is a measure that is used to understand how an individual believes they fall socially in their society on the basis of educational level, income, occupation, and other common factors associated with SES and social position or class (Adler & Stewart, 2007). SSS has been found to be associated with poor self-rated health, increased mortality, depression, cardiovascular disease risk and diabetes (Adler & Stewart, 2007). Research shows that there is a positive relationship between subjective social status and self-reported physical and mental health (Garza et al., 2017).

<u>Homelessness</u>

Section 330 of the Public Health Service Act defines a homeless individual as someone who lacks housing, sleeps in a public or private facility that is supervised and provides temporary living accommodations, or one who resides in transitional housing (Public Health Service Act). Immigrants are vulnerable to homelessness because of challenges that increase their likelihood of living in poverty (Gilleland et al., 2016). Some

unique challenges immigrants face are language barriers, being forced to accept low paying jobs, cultural differences, legal status, and education level (Gilleland et al., 2016).

Stress of Immigration / Demands of Immigration

Stress of immigration or demands of immigration are factors specific to immigrants and the migration process that cause stress otherwise not faced by the native-born population. Examples of immigrant specific factors that may cause stress include: limited English proficiency (LEP), undocumented status, disadvantages or discrimination in the workplace, desire to be with family who are in the home country, feelings of nostalgia when thinking about the home country, feelings of confusion or discomfort with US culture (cultural dissonance), feeling lonely or socially isolated, disruption in the family's stability, and loss of social status (Sternberg et al., 2016; Hattar-Pollara & Meleis, 1995). Documentation and citizenship status have been shown to be associated with immigrant health status. Undocumented immigrants have been found to have higher blood pressure than documented immigrants who have been in the US for less time (Young & Pebley, 2017). When looking at Latino immigrants, it was found that those who were not citizens had poorer health compared to those with citizenship (Guzman et al., 2018). Hispanics also report stress due to immigration status (Smith-Miller et al., 2017), and immigrants who face discrimination were more likely to report having chronic pain (Mirpuri et al., 2018).

Enabling Factors

Health Care Access

Health care access is a concept that represents the fit between patients and the health care system; and is made up of five dimensions (Penchansky & Thomas, 1981).

The five dimensions of access include: availability, accessibility, accommodation, affordability, and acceptability (Penchansky & Thomas, 1981). 1) Availability is defined as the relationship between the amount of existing services (supply) for patients and the volume of patient needs (demand) (Penchansky & Thomas, 1981). 2) Accessibility is defined as the relationship between the location of health services and the patient's ability to travel taking into account distance and cost (Penchansky & Thoams, 1981). 3) Accommodation is defined as the relationship between appointment services in terms of availability, walk-in options, scheduling services and the patient's ability to obtain an appointment using available services (Penchansky & Thomas, 1981). 4) Affordability is defined as the relationship of prices of health care services, insurance coverage, and the patient's ability to pay (Penchansky & Thomas, 1981). 5) Acceptability describes the relationship between the patient's perceptions of providers and the actual characteristics of providers (Penchansky & Thomas, 1981). Differences in health care access have been seen among recent immigrants and non-recent immigrants. Recent immigrants or those who have resided for less than 5 years in the US were more likely to be below 150% of the federal poverty level and were more likely to seek care at a clinic or health center instead of in a doctor's office (Vega et al., 2018). Research also shows there to be a much higher proportion of recent immigrants aged 55 and older who have not seen a health professional for non-emergency purposes in the last year compared to non-recent immigrants or those who have resided in the US for more than 5 years (Vega et al., 2018).

Insurance Status

Health insurance coverage has been identified as a key indicator of access to health care. Uninsured individuals are less likely to have a usual source of health care,

less likely to have had a recent health care visit, and less likely to be current with recommended preventative care screenings (National Center for Health Statistics, 2017). Immigrants have significantly lower prevalence of having health insurance compared to US born laborers. Additionally, individuals with citizenship were more than three times likely to have health insurance coverage compared to non-citizens (Hammig et al., 2018).

Perceived Discrimination

Perceived discrimination is defined as the belief that negative attitudes, judgment or unfair treatment occurs towards members of a vulnerable or often marginalized group (Pascoe & Richman, 2009). Perceived discrimination is an uncontrollable and unpredictable stressor that has been found to be associated with physical health problems such as hypertension, diabetes, self-reported poor health, substance use, quality of life and glycemic control in individuals with diabetes (Pascoe & Richman, 2009; Dawson et al., 2015; Achuko et al., 2016; Dawson et al., 2016). Perceived discrimination is associated with high levels of psychological distress and poor self-reported health in immigrants (Halim et al., 2017). Perceived discrimination has been shown to be positively associated with stress and systolic blood pressure; and indirectly negatively associated with blood glucose control and the mental component of quality of life in individuals with type 2 diabetes (Dawson et al., 2015; Dawson et al., 2016; Achuko et al., 2016).

Perceived Stress

Perceived stress is an individual's beliefs about how much stress they are experiencing at a given point in time (Phillips, 2013). Acculturative stress and perceived social support were identified as key predictors for depression and anxiety in a Korean immigrant population (Koh, 2018). Stress due to financial instability, lack of medication

adherence, and disease progression have been identified as factors that negatively affected glycemic control and physical well-being in Hispanics (Smith-Miller et al., 2017). High levels of acculturative stress are also shown to be associated with high levels of psychological distress (Da Silva et al., 2017). Multiple studies have shown negative associations between stress and mental health outcomes (Koh, 2018; Da Silva et al., 2017; Fernández-Esquer et al., 2018). Additionally, immigrant populations face stress as a result of chronic discrimination, negatively impacting mental health (Flores et al., 2008).

Health Literacy

Title V of the Patient Protection and Affordable Care Act defines health literacy as one's ability to "obtain, communicate, process, and understand health information and services in order to make appropriate health decisions." (Title V, ACA) Immigrants frequently have language barriers that make understanding the processes of daily living in the US challenging (Coffman & Norton, 2010; Kreps & Sparks, 2008; Shaw et al., 2009). As a result of language barriers and other factors, widespread low health literacy has been documented in Hispanic/Latino and other immigrants (Coffman & Norton, 2010). Immigrants have trouble recognizing and reporting symptoms of depression and other conditions because they may be unaware of treatment options or unable to navigate the healthcare system in the new country (Coffman & Norton, 2010; Kreps & Sparks, 2008). Low health literacy has also been found to be associated with poorer health related knowledge and comprehension, increased hospitalizations and emergency care, and decreased preventative screening and care such as mammography and receipt of influenza vaccines (Berkman et al., 2011).

English Proficiency

Individuals who do not speak English as their primary language and who have limited ability to read, speak, write, or understand English are considered to have limited English proficiency (LEP) (Limited English Proficiency, 2011). Many individuals with LEP also report low health literacy. Language barriers may result in fewer visits to providers, delays in preventative services, misunderstandings regarding diagnosis, treatment, and self-care options (Coren et al., 2009; Carrasquillo et al., 1999; Derose et al., 2000). LEP can also result in inappropriate use of medications, lack of informed consent for procedures, longer hospital stays, higher hospital readmission rates, less health education, poor patient satisfaction, and poor comprehension by patients of follow-up care plans (Coren et al., 2009; Morales et al., 1999; Carrasquillo et al., 1999; Sarver et al., 2000; Schenker et al., 2007; John-Baptiste et al., 2004; Ngo-Metzer et al., 2007; Karliner et al., 2010). Spanish-speaking Latinos and other immigrants with LEP reported poorer self-rated health compared to English-speaking Latinos or those without LEP (Guzman et al., 2018; Sentell & Braun, 2012; Okafor et al., 2013).

Bicultural Self-Efficacy

Bicultural self-efficacy is considered as the ability to function competently in two distinct cultures (David et al., 2009). One of the models of second-culture acquisition states that it is possible for an individual to know and understand two different cultures; it also assumes that individuals are capable of adjusting their behavior to fit specific contexts within each culture (LaFromboise et al., 1993). LaFromboise et al propose that individuals may have better physical and psychological health if they are able to learn and fit into both the old and new culture (LaFromboise et al., 1993). Research has shown that fully bicultural individuals were more like to rate their physical and mental health as excellent/very good/good instead of as fair or poor (Jang et al., 2017).

Acculturation

Acculturation can be defined as a multidimensional process in which the practices, values, and identifications adopted from one's home country combine with those of the new country where one resides (Schwartz et al., 2010; Lara et al., 2005; Wells et al.,1989). Individuals form Sub-Saharan Africa realize that there are negative effects associated with adopting an Americanized diet; recognizing that North American foods should be replaced with foods from the home country when managing diabetes (Kindarara et al., 2017). However, immigrants are frequently faced with barriers to maintaining their diet upon arrival in the US because the native foods are not easily accessible as they are in the home country (Kindarara et al., 2017). Additionally, immigrants have found that healthy foods are too expensive to afford (Kindarara et al., 2017). Examples of dietary changes frequently faced by immigrants include: increasing the amount and frequency of meats, drinking sodas, eating processed foods, and snacking (Borre et al., 2010). In addition to dietary changes, lifestyle changes in the amount and types of physical activity completed while in the US compared to the home country are also frequently reported among immigrant groups. For example, individuals from Sub-Saharan Africa with type 2 diabetes report walking less in the US than in their home countries (Kindarara et al., 2017).

Need Factors

Health and Disability / Health Status

Disability is defined as an impairment, activity limitation, or condition that restricts one's ability to participate in day-to-day activities (WHO, 2018a). Disability is also considered as the interaction between individuals with a health condition and

personal and environmental factors such as attitudes, inaccessible transportation, and

limited social supports (WHO, 2018a). Asian and Hispanic immigrants have been found

to have poorer health than NHW immigrants (Danso, 2016). Immigrants have reported

higher food insecurity than US-born individuals. Latino immigrants regardless of

immigration status have been found to be twice as likely as US-born Whites and about

50% more likely than US-born Latinos to report food insecurity (Walsemann et al.,

2017). Latinos have been found to generally be more food insecure than Asians, except

that immigrant Asians were more food insecure than US-born Latinos (Walsemann et al.,

2017). Migrant farm workers have also been found to be susceptible to food insecurity

(Borre et al., 2010). Migrant farm workers while residing in their home countries were

food insecure because there were no opportunities to work and no money to buy food

(Borre et al., 2010). Here in the US there are opportunities for work, but there is

insufficient time to buy and prepare healthy foods; so people find it to be faster and easier

to eat processed and fast foods (Borre et al., 2010).

Chronic Conditions

Chronic conditions are diseases that generally last for three months or longer and

may progress overtime (National Cancer Institute, 2018). Chronic diseases are frequently

caused by smoking or exposure to secondhand smoke, poor diet, insufficient exercise,

and excessive alcohol use (CDC, 2018a). Some examples of chronic diseases include:

heart disease, cancer, diabetes, hypertension, and stroke (CDC, 2018a). Some

immigrants who have LEP and a chronic disease such as diabetes report not receiving any

instruction or ongoing education about self-management of diabetes and for those who

receive education indicated that frequently classes are only in English (Smith-Miller et

al., 2017). Additionally, the longer immigrants reside in the US the more likely they are

to have multiple cardiovascular disease risk factors including obesity and high

cholesterol; and the more likely they are to take on the health profile of the native

population (Koya et al., 2007; McDonald & Kennedy, 2004). Foreign-born individuals

have been found to be less likely to receive dietary and exercise counseling than US-born

individuals (Goel et al., 2004).

<u>Chronic Pain</u>

Chronic pain is defined as pain that lasts for three months or longer (National

Institutes of Health, 2011). Causes of chronic pain frequently include injuries or illness

(NIH, 2011). Individuals who suffer from chronic pain may have limited mobility,

reduced flexibility and strength resulting in decreased ability to execute daily activities

(NIH, 2011). Cultural differences in the way pain is described may affect an individual's

report of pain severity (Bates et al., 1993). Also, individuals who are from cultures where

pain is accepted or encouraged may also lead to underreporting of pain or pain severity

(Bates et al., 1993). One study by Bates et al highlights the importance of paying

attention to the cultural background, cultural reporting styles, and cultural attitudes

around pain when treating immigrant patients (Bates et al., 1993).

Outcomes

<u>Systolic Blood Pressure</u>

Systolic blood pressure is a measure of the pressure in blood vessels when the

heart beats and has been identified as a risk factor for cardiovascular disease (CDC,

2017b; American Heart Association, 2018). Conflicting results have been found

regarding the prevalence of hypertension among foreign-born and US born adults. Some

studies show that hypertension is more prevalent among US-born NHB compared to

foreign-born NHB (Brown et al., 2017). Social determinants associated with hypertension were different across 3 different African ancestry based ethnic groups. In African Americans higher SES was associated with a lower likelihood of having hypertension (Commodore-Mensah et al., 2017). In African immigrants having health insurance was associated with a higher likelihood of a self-reported diagnosis of hypertension (Commodore-Mensah et al., 2017). In Afro Caribbean immigrants there was an inverse association between income and diagnosed hypertension. Similar phenomenon has been seen with hypertension. The odds of having hypertension have been found to be lower for Mexican men who lived in the US less than 5 years and for those who resided in the US 5 – 19 years compared to those who lived in the US for 20 years or more (Dinwiddie et al., 2014). Mexicans who lived in the US for less than 5 years had better health profiles than those with more than 5 years of residence in the US (Dinwiddie et al., 2014).

Current Gaps in Knowledge

Little research has been done to explain the changes seen over time in immigrant health. Additionally, there is no theory-based conceptual model that can be used to understand the relationship between social determinants of health and blood pressure control in adult immigrants. While prior health services models identify antecedents, predisposing, enabling and need factors as drivers of health utilization and outcomes, these models do not adequately account for social determinants of health or incorporate immigrant specific factors. Immigration policies and increasing rates of deportation in the United States, increasing stress, and decreasing access to health care have resulted in negative impacts on health and well-being for this population (Castañeda et al., 2015; Muñoz et al., 2015; Hacker et al., 2012; Ojeda et al., 2011). More research is needed to

understand the relationship between the way in which these factors influence health, and how interventions can be developed to improve the health of immigrants. There is limited information on the relationship between antecedents, predisposing, enabling, and need factors; and systolic blood pressure immigrants in the United States. This study examined in depth the relationship between social determinants of health and blood pressure control. New latent variables with greater explanatory power were identified; and the new Dawson and Egede conceptual model that is based on theory was tested and validated, and will serve as the foundation for future social determinants and immigrant health work, and as the foundation for the development of future interventions. This study is of paramount importance given the increase in immigration worldwide and addresses many gaps in the literature surrounding social determinants of health and blood pressure in US adult immigrants.

METHODOLOGY

Overview of the Study

This was a cross-sectional study of 181 foreign-born adults who were recruited from the Greater Milwaukee Area in the state of Wisconsin. The goal of this study was to examine the relationship between social determinants of health and systolic blood pressure (SBP) among immigrants in the United States using a conceptual model that includes previously validated measures of antecedents, predisposing, enabling, and need factors. The study goal was addressed through four aims.

Aim 1: The first aim was to examine the relationship between immigrant specific social determinants of health and blood pressure control in US immigrant adults using regression analysis.

Aim 2: The second aim was to use a theory-based model to create latent variables that define immigrant specific social determinant of health and use confirmatory factor analysis and structural equation modeling to test theoretical validity and their relationship with systolic blood pressure in US immigrant adults.

Aim 3: The third aim was to identify direct and indirect pathways of the relationship between latent variables for immigrant specific social determinants and blood pressure control among US immigrant adults using structural equation modeling.

Aim 4: The fourth aim was to validate a theory-based conceptual model that incorporates indicator variables for immigrant specific social determinants classified as antecedent, predisposing, enabling, and need factors and assess their relationship with blood pressure using path analysis.

<u>Study Population and Recruitment Plan</u>

The Medical College of Wisconsin Institutional Review Board approved the protocol and all study procedures prior to initiating study recruitment and enrollment.

<u>Study Sites:</u> Given the known challenges of recruiting minorities and immigrants for research studies, we used complementary strategies to optimize recruitment. These included recruitment from academic medical centers; local colleges and universities; community sites, including churches, food pantries, community centers, public housing developments, libraries, barber shops, beauty salons; and other public locations in the greater Milwaukee area.

<u>Recruitment Strategy:</u> A variety of complementary methods were used to identify eligible study participants, including "snowball sampling" within the immigrant population. Detailed recruitment strategies are provided below.

<u>Clinic Recruitment:</u> The first method involved systematically identifying patients seen in the MCW General Internal Medicine (GIM) clinic. Using the MCW Clinical Data Warehouse, potential participants were identified and their contact information for recruitment was obtained using the Cohort Discovery Tool (CDT). After obtaining Institutional Review Board (IRB) approval for a partial waiver of HIPAA, the CDT allows searching of clinic-billing records over the last 12-months to identify patients who have been seen in the GIM clinics. The clinic leadership was notified of their patients' potential eligibility and permission was obtained to contact patients for the study. After consent was obtained from the clinic leadership, letters of invitation on clinic letterhead signed by clinic leadership were mailed to patients from the study offices. The recruitment letter provided information about the study, explained the study requirements, and clarified that only participants who met certain criteria would be

eligible to participate in the study. The letter included an addressed and stamped post-

card that individuals could mail back to indicate interest or lack of interest in

participating in the study. In addition, the letter provided a telephone number that

interested participants could call to receive detailed information about the study. Patients

were also informed that they would receive a follow-up call in two weeks unless they

mailed back the post card or called to decline being contacted. Interested individuals who

mailed back the post card or called the provided telephone number received detailed

information about the study. Individuals who agreed to participate were asked to provide

written consent, were given the survey and had their height, weight, and blood pressure

collected. In addition to this method, recruitment was focused in the community.

Community-based Recruitment: Institutional Review Board (IRB) approved

recruitment flyers were posted in prominent locations including but not limited to

libraries, community centers, recreation centers, centers of worship (i.e. churches,

mosques, Hindi temples), grocery and convenience stores, schools, shopping centers,

barbershops, beauty salons, restaurants, and lawyers' offices. Interested participants

contacted study staff in response to recruitment flyers for the study.

Media Recruitment: The recruitment flyer was posted in MCW newsletters and

media, local newspapers, social media, radio and television, as well as local public

community organizations, local agencies, community student organizations, local health

fairs.

Snowball Recruitment: Research participants were asked to assist in recruitment

efforts by identifying other potential individuals and/or passing along flyers that

contained contact information for the study staff to reduce undue influence, breach in

confidentiality, or an invasion of privacy. Regardless of the method of recruitment,

individuals interested in participating in the study received detailed information about the study.

Participant Payment: Participants received a $25 gift card for completion of the survey and provision of height, weight, and blood pressure measurements.

Patient Population and Feasibility of Recruitment: Milwaukee County, Wisconsin had an estimated population of 952,085 in July 2017 (US Census Bureau, 2017). About 8.8% of the population or approximately 83,783 individuals are foreign-born (US Census Bureau, 2017). The city of Milwaukee is composed of about 595,070 people, about 20% speak a language other than English, and about 6% (35,704) are not US citizens (Data USA, 2016). The top three countries of origin for foreign-born individuals who reside in Milwaukee are Mexico, India, and Germany (Data USA, 2016). While the median age of everyone in the city of Milwaukee was 31 years of age, the median age for US born was 30, and for foreign-born was 38.9 years of age (Data USA, 2016). The most common languages of those who speak a language other than English include: Spanish, Hmong, Arabic, Laotian, and Serbo-Croatian (Data USA, 2016). Based on previous experience using the comprehensive recruitment strategy outlined above and appropriate patient incentives, it was expected that at least 20% of eligible subjects would be willing to participate.

Participant Eligibility Criteria: The study inclusion and exclusion criteria were as follows:

Inclusion Criteria: 1) age $\geq$ 21 years; 2) willingness to have vital signs measured at study visit.

Exclusion Criteria: Mental confusion on interview suggesting significant dementia, active psychosis, or intoxication.

Data Collection

Personnel: Two program managers, three program coordinators, and one community health worker conducted all study assessments and entered all study related data into a secure web-based data system. Two of the study team members were English/Spanish bilingual and completed study visits in English or Spanish depending upon the participant's preference. Members of the study team performed all related data tracking and coordination duties.

Study Visit: At the study visit, study personnel gave a detailed explanation of the study and obtained consent. The study personnel asked participants to complete validated questionnaires that captured social determinants of health factors along with sociodemographic information. Additionally, study personnel measured blood pressure according to American Heart Association guidelines (American Heart Association, 2018) using automated OMRON BP monitors (OMRON BP742N).

Primary Outcome Measure

Primary outcome measure of systolic blood pressure (SBP) was collected by study staff. Blood pressure readings were obtained using automated BP monitors (OMRON BP742N).

Social Determinants of Health

Antecedents

Region/Country of Origin: Region and country of origin were assessed by asking the participant to choose their region of birth.

Ethnicity/Race: Previously validated items from the National Health Behavioral Risk Factor Surveillance System (CDC, 2014b) were used to capture race/ethnicity.

Life-course Socioeconomic Status (Life-course SES): Life-course SES was measured through a series of questions to understand early-life socioeconomic disadvantage. These variables included the education level of the father, education level of the mother, size of family, birth order, and level of education (Wamala et al., 2001). A disadvantage index was created based on recommendations for measuring life course socioeconomic factors (Pollitt et al., 2005). Individuals who were born last, had more than three siblings, had less than a high school education, parents had less than a high school education, earned less than $25,000 per year, and were unemployed were each assigned one point, after which scores were summed for the individual to obtain a score of 0-7 with higher numbers indicating lower life-course SES.

Predisposing Factors

Demographic Factors: Previously validated items from the National Health Behavioral Risk Factor Surveillance System (CDC, 2014b) were used to capture age, sex, marital status, education, occupation, and household income.

Homelessness: History of homelessness was assessed using the segment Homeless History from the 1990 Course of Homelessness Study conducted by The Rand Corporation out of California (RAND, 2018). Questions assessed age and frequency of homelessness as well as prison time and enlistment into the Armed Forces.

Border Community and Immigration Stress: The BCISS is a 21-item validated scale that measures stressful experiences and migration pressures in foreign born individuals (Carvajal et al., 2013). Respondents were asked the degree to which they find

various circumstances stressful as it relates to migration. Responses ranged from "not at all stressful" to "extremely stressful".

Demand of Immigration: The DI scale is a validated scale that measures distress related to migration and leaving friends and family behind (Ding et al., 2011). Respondents were asked to rate on a scale ranging from 1-Strongly Agree to 5-Strongly Disagree their dependence on and need of family who are currently located in home country. The level of comfort interacting within a foreign culture as it pertains to language and occupation were also included in this measure.

Enabling Factors

Health Care Access: Previously validated items from the 2010 Medical Expenditure Panel Survey – Household Component (MEPS, 2010) and Behavioral Risk Factor Surveillance System (CDC, 2014b) were used to capture having a usual source of care, the number of visits to primary care, travel time to receive care. Also, previously validated items from the National Health Behavioral Risk Factor Surveillance System (CDC, 2014b) were used to capture health insurance.

Perceived Discrimination: Previously validated items from the DISTANCE survey (Moffet et al., 2009) were used to capture perceived discrimination. Patients self-report on how often in the past 12 months they felt they were treated poorly or made to feel inferior because of race/ethnicity, level of education, sex/gender, or language.

Perceived Stress: The perceived stress scale (PSS) is a 4-item scale that assesses the degree to which the respondent finds situations stressful (Cohen & Williamson, 1988). Responses range from "0" (never) to "4" (very often) and questions ask about the frequency of feelings related to events in the previous month (Cohen & Williamson,

1988). The Cronbach alpha value is 0.69 and scores are highly correlated with stress, depression and anxiety (Andreou et al., 2011).

Health Literacy: Health literacy was measured by the 3-item Chew literacy scale (Chew et al., 2008). The scale measures respondents' capacity to obtain, process, and understand basic health-related decisions (Chew et al., 2008).

English Proficiency: The Marin and Marin Acculturation Scale was used to assess English proficiency. The measure is a previously validated scale that asks for the participant to indicate their primary or first language and asks 5 questions about preferred language use in personal life and 3 questions about preferred language use for media. Answer choices include: only primary language, more primary language than English, both equally, more English than primary language, or only English. The scale also consists of 4 questions about preferred language for ethnic social relations. (Marin et al., 1987).

Bicultural Self-Efficacy: Bicultural Self-Efficacy was assessed using a 26-item scale (David et al., 2009). The scale assessed social groundedness, communication ability, positive attitudes, knowledge, role repertoire, and bicultural beliefs, in foreign born individuals.

Acculturation: The Marin and Marin Acculturation Scale is a previously validated scale (Marin et al., 1987) that assess acculturation on three subscales (Language, Media, and Ethnic Social Relations). Items were assessed using 5-point Likert scale and scores are summed to calculate acculturation score.

Need Factors

Disability: Disability was measured with the 8 previously validated items used by the Behavioral Risk Factor Surveillance System (CDC, 2014b) to capture health problems or impairments. Questions ask about limitations due to health, need for special equipment, and difficulty with task such as climbing stairs or going to the doctor office.

Chronic Conditions: Previously validated items from the Behavioral Risk Factor Surveillance System (CDC, 2014b) were used to capture the existence of medically comorbid conditions.

Chronic Pain: Previously validated items from the Diabetes Study of Northern California (DISTANCE) survey (Moffet et al., 2009) were used to capture chronic pain and functional disability. Patients self-reported on the amount of bodily pain including how much it interfered with sleep, whether the pain was present most of the time, and whether it had been discussed with a doctor.

Data Entry and Management

All data was entered into REDCap database, integrated data quality and consistency checks (e.g. data range checks) were part of the data entry procedure after it had been deidentified. Data quality was monitored and assured in several ways: 1) as reported; and 2) as entered into the study database. For the former, all hardcopy data forms were visually inspected by project staff before data entry. Furthermore, a manual comparison of randomly selected data hardcopy forms with data output listing generated from the study database were performed, and consistency checks were generated by Stata as part of routine data cleaning procedures. Surveys remained stored in a locked cabinet in the Center for Advancing Population Science (CAPS) at MCW.

Sample Size Calculation and Power Analyses

The study included 181 foreign-born adults. For aim 1, with 181 participants, the

analyses to evaluate the univariate relationships had 80% power to detect an association

of at least $\rho=0.3$, where ρ represents the population correlation between the dependent

and each primary independent variable. For the multivariate analyses involving

evaluation of the relationship between social determinants and outcomes for each primary

independent variable adjusted for covariables (e.g., age, sex, education, income, and

employment), we were able to detect with 80% power an increment of at least 10% in R^2

for a given primary independent variable, over and above the contribution of the

covariables. Specifically, the increment in R^2 represents the proportion of variation in the

outcome variable accounted for by each primary independent variable over and above

that explained by the covariables. As defined by Cohen (Cohen & Williamson, 1988) we

had 80% power to detect between a small effect (primary independent variable accounts

for 2% of the variance of the dependent variable) and a moderate effect (primary

independent variable accounts for 13% of the Y variance).

For aims 2, 3, and 4, a sample size of 181 provided adequate power to use

structural equation modeling (SEM) and path analysis. In confirmatory factor analysis

(CFA) and SEM, a larger sample size is necessary to maintain power while estimating

parameters and standard errors (Schumaker & Lomax, 2010; Kline, 2016). Sample size

influences the calculation of minimum fit function and smaller sample sizes do not give

enough information without saturating the model with variables (Schumaker & Lomax,

2010). In this analysis, power was maintained by limiting inclusion of variables based on

significant relationships existing in univariate comparisons. This also assisted in ensuring

we did not overfit the model by incorporating multiple variables that measured similar constructs. Confirmatory factor analysis was used to identify appropriate variables to create latent factors and those with low loading were removed. Finally, a sample size of 181 provided an adequate sample to accomplish SEM and path analysis, and maintained power while minimizing possibility of over-saturating the model, and ensuring stable and reliable estimates in all models planned in the analysis.

Data Analysis

Analysis Data Sets

After the data was cleaned and quality control checks were implemented, preliminary data analyses were conducted using univariate descriptive statistics and frequency distributions as appropriate for the variables. All data analyses were conducted with Stata version 14.

Analysis Plan for Aim 1

Aim 1: To examine the relationship between immigrant specific social determinants of health and blood pressure control in US immigrant adults using regression analysis.

The primary independent variables were antecedents (life-course SES), predisposing factors (age, sex, marital status, education, employment, household income, subjective social status, homelessness history, border community and immigration stress, demand of immigration), enabling factors (healthcare access, insurance status, perceived discrimination, perceived stress, health literacy, English proficiency, bicultural self-efficacy, acculturation), and need factors (disability, health status, chronic conditions,

chronic pain). The primary outcome variable was systolic blood pressure. Primary

analyses used three regression methods: sequential, stepwise with backward selection,

and all possible subsets regression. Variables were retained if p was less than or equal to

0.2. Retained variables were used to model the association with systolic blood pressure

and significance was determined using a p-value of ≤ 0.05 and R^2 values.

Analysis Plan for Aim 2

Aim 2: To use a theory-based model to create latent variables that define

immigrant specific social determinant of health and use confirmatory factor analysis and

structural equation modeling to test theoretical validity and their relationship with

systolic blood pressure in US immigrant adults.

Confirmatory Factor Analysis (CFA) was be performed using Stata version 14.

Variables were grouped into four categories based on the proposed Egede and Dawson

model. The objective was to collapse the set of variables into the most parsimonious

category possible. The first category was antecedents and included: life-course SES. The

second category was predisposing factors and included: age, sex, marital status,

education, employment, household income, subjective social status, homelessness

history, border community and immigration stress, demand of immigration. The third

category was enabling factors and included: healthcare access, insurance status, perceived

discrimination, perceived stress, health literacy, English proficiency, bicultural self-

efficacy, acculturation. The fourth category was need factors and included: disability,

health status, chronic conditions, chronic pain. The fifth category was outcome and

included: systolic blood pressure.

The maximum likelihood extraction method was used with oblique rotation for all variables with normal distribution, allowing for a wide range of goodness of fit indexes and testing of factor loading and correlations among factors (Costello & Osborne, 2005). After latent variables were created, CFA was used to determine if the variables were statistically significant. Once the model had been finalized, modification indices were computed in Stata and used to improve the fit of each latent variable. Examples of these indices include p-value, root mean squared error of approximation (RMSEA), comparative fit index (CFI), Tucker-Lewis Index (TLI)and the coefficient of determination (CD). Indicators of good model fit include: p-value that is not significant, RMSEA < 0.008, CFI and TLI >0.95, and or a CD >0.95.

Analysis Plan for Aim 3

Aim 3: To identify direct and indirect pathways of the relationship between latent variables for immigrant specific social determinants and blood pressure control among US immigrant adults using structural equation modeling.

 SEM is defined as a causal inference method that uses inputs to create outputs or s methodology used to test a theory by specifying a model that represents predictions of the theory using measures obtained from appropriate variables (Kline, 2016) . Examples of inputs include qualitative causal hypotheses that are based on theory or results of quantitative studies that are represented in a model; a set of questions about causal relationships between variables of interests. SEM is able to generate outputs such as numeric estimates of model parameters for hypothesized effects; sets of implications that may not correspond to a specific parameter but that can be tested in the data. Using measurement and structural models SEM can show the pattern of observed variables for

latent constructs in the hypothesized model; and can show the interrelations among latent constructs and observable variables in the hypothesized model (Schreiber et al., 2006). Latent variables for antecedents, predisposing, enabling, and need were tested to assess their relationship with systolic blood pressure.

Analysis Plan for Aim 4

Aim 4: To validate a theory-based conceptual model that incorporates indicator variables for immigrant specific social determinants classified as antecedent, predisposing, enabling, and need factors and assess their relationship with blood pressure using path analysis.

Path analysis allows for the inclusion of multiple independent and dependent variables; because of this characteristic multiple regression models can be ran simultaneously (Schumacker & Lomax, 2010). Five steps of path analysis and SEM were followed to validate the proposed conceptual model: model specification, model identification, model estimation, model testing, and model modification. The model identification was based on the direct and indirect paths identified in SEM, and the model was specified based on the proposed Dawson and Egede model. Model testing was conducted using Stata 14 and included the evaluation of model p-value, RMSEA, and CFI.

Manuscript 1: Relationship between Social Determinants of Health and Systolic

Blood Pressure in United States Immigrants

Abstract

Objective: This study examined the relationship between immigrant specific social

determinants of health (SDoH) and blood pressure control.

Methods: Data on 181 adult immigrants from the Midwestern United States was

analyzed. SDoH variables were categorized based on antecedents, predisposing, enabling,

and need factors. Systolic blood pressure (SBP) was the primary outcome. Pearson's

correlations for the association between SBP and SDoH variables were assessed. Then

three different regression approaches were used to assess the relationship of SDoH

variables with SBP: sequential model, stepwise regression with backward selection, and

all possible subsets regression.

Results: Age (r=0.34, p<0.001), disability (r=0.20, p=0.0001), comorbidities (r=0.30,

p<0.001), and chronic pain (r=0.12, p=0.02) were positively correlated with SBP, and

number of hours worked per week (r=-0.11, p=0.028) was negatively correlated with

SBP. The final sequential model found life-course socioeconomic status (SES) (β=1.40,

p=0.039), age (β=0.39, p<0.001), and male sex (β=13.62, p<0.001) to be positively

associated with SBP. Stepwise regression found that life-course SES (β=1.70, p=0.026),

age (β=0.36, p<0.001), male sex (β=13.38, p<0.001), and homelessness as a child

(β=13.14, p=0.034) were positively associated SBP. All possible subsets regression found that age (β=0.44, p<0.001), male sex (β=14.50, p<0.001), and homelessness as a child (β=14.08, p=0.027) were positively associated with SBP.

Conclusion: This is the first study to use a theory-based model that incorporates social determinants of health and immigrant specific factors to examine the relationship between SDoH and blood pressure control and identifies potential targets for interventions to control BP in immigrants.

Introduction

High blood pressure or hypertension affects approximately 75 million or 32% of adults in the United States (US) and costs the nation about $48 billion annually due to the cost of health services, medications, and missed work days (CDC, 2016). The global prevalence of hypertension was about 40% in 2008 (WHO, 2018), and is estimated to cause 7.5 million deaths worldwide, accounting for approximately 57 million disability adjusted life years (DALYs) (CDC, 2016; WHO 2018). While high blood pressure is a prevalent condition, differences in prevalence between native born and foreign-born populations have been noted (Brown et al., 2017; Commodore-Mensah et al., 2018; Ghobadzadeh et al., 2015; Shah et al., 2015; Young & Pebley, 2017; Koya & Egede, 2007; Rosenthal et al., 1989).

Data from the 2014 US Census Bureau show that 42.4 million documented and undocumented immigrants live in the United States (US), making up 13.3% of the nation's population and this number is expected to continue to increase (Camarota & Zeigler, 2016). Studies have demonstrated differences in morbidity and mortality from hypertension between immigrants and US born adults and these differences have been attributed to genetic factors, biological factors and lifestyle factors (Brown et al., 2017; Zallman et al., 2013; Fang et al.,

2018; Hall & Cuellar, 2016; Yi et al., 2016; Bamimore et al., 2012). However, important contributors to these differences that have not been well studied are social determinants of health. Social determinants are factors such as where people are born, live, work, and age that contribute to health inequities and preventable health disparities in the US and other countries (WHO, 2017; CDC, 2017). The lives of immigrants are influenced by social determinants experienced in their countries of birth as well as by new social determinants experienced in the country of immigration (Castañeda et al., 2015).

Immigrants have differences in lifestyle and diet that may affect their risk for developing chronic diseases such as hypertension (Lesser et al., 2014; Holmboe-Ottesen & Wandel, 2012; Okafor et al., 2014; Yang & Read, 1996). Research shows that immigrants have significantly lower daily intakes of sugar-sweetened beverages, red and processed meat, and sodium; and have higher intakes of vegetables, fruit, and whole grains compared to US-born individuals (Brown et al., 2017). These findings support the idea that immigrants have more favorable health behaviors that are associated with lower risk of chronic disease (Brown et al., 2017). It is well known that more-recent immigrants have lower blood pressure than those living in the US for longer periods of time (Brown et al., 2017; Young & Pebley, 2017; Koya & Egede, 2007; Rosenthal et al., 1989; Commodore-Mensah et al., 2016). This phenomenon is true not only for the US, but for other countries around the world (Shah et al., 2015; Rosenthal et al., 1989; Carlsson et al., 2008; Reuven et al., 2016). The prevalence of hypertension among immigrants has frequently been found to be higher than that of individuals in the home country and in some cases higher than that of native-born individuals (Shah et al., 2015). While it is not believed that foreign-born individuals have genetic changes or mutations that increase or decrease their risk for hypertension compared to native-born individuals; research shows that birthplace is associated with hypertension (Poston et al., 2001). This suggests that cultural, lifestyle, and environmental

differences, or social determinants of health, between foreign- and native-born contribute to differences in prevalence of hypertension (Poston et al., 2001).

In spite of strong evidence linking social determinants of health to poor health outcomes for chronic conditions like hypertension, there is limited research that uses theory-based conceptual models to understand the associations between social determinants and outcomes such as blood pressure amongst diverse immigrant groups in the US. Specifically, little has been done to incorporate social determinants of health into traditional models of health services utilization and outcomes or evaluate the contribution of antecedents, predisposing, enabling, and need factors on hypertension control in immigrants. Therefore, the aim of this study was to use a theory-based model that incorporates social determinants of health and immigrant specific factors to examine the relationship between antecedent factors (i.e. region/country of origin, ethnicity/race, life-course socioeconomic status), predisposing factors (i.e. age, sex, marital status, education, employment, household income, subjective social status, homelessness history, border community and immigration stress, demand of immigration), enabling factors (i.e. healthcare access, insurance status, perceived discrimination, perceived stress, health literacy, English proficiency, bicultural self-efficacy, acculturation), and need factors (i.e. disability, health status, chronic conditions, chronic pain); and blood pressure control in a diverse population of immigrants in the Midwestern United States. We hypothesized that in a theory-based model that incorporates social determinants of health and immigrant specific factors, antecedents, predisposing, enabling, and need factors will be significantly associated with blood pressure control in an immigrant population.

Methods

Study Population

This was a cross-sectional study of 181 immigrants, defined as individuals who reported being born outside of the United States and its territories, ages 21 and older that were recruited from the Greater Milwaukee Area. The Medical College of Wisconsin (MCW) Institutional Review Board (IRB) approved the protocol and all study procedures prior to commencement of study enrollment. We used a variety of complementary methods to identify eligible study participants within the immigrant community including clinic, community-based, media, and snowball recruitment. Patients were determined to be ineligible if signs of acute psychosis, dementia, or intoxication were demonstrated prior to obtaining informed consent. Individuals were provided a detailed description of the study and written informed consent was obtained. Participants then completed the in-person questionnaire that was made up of validated measures in either English or Spanish depending upon participant preference. Trained, bilingual research staff read the survey to participants in Spanish for Spanish-speaking individuals if requested. Blood pressure was obtained by members of the research study team using established guidelines.

Conceptual Model

Variables selected for inclusion in the model were based on a conceptual model developed using components of three health services research models and incorporating social determinants of health and immigrant specific variables. Social determinants of health variables were categorized based on predisposing, enabling, and need factors as defined by Andersen in 1995, and antecedents and outcomes as defined by Coyle and Battles in 1999 (Andersen, 1995; Coyle & Battles, 1999). Immigrant specific factors noted in the Yang & Hwang model of 2016 were additionally added to the conceptual model (Yang & Hwang, 2016). The final model, showing in Figure 8, provided the conceptual framework under which variables were considered and entered into analyses. Each construct was measured using validated measures described

below. This model fills a gap in the literature by providing a health services research model that is specific to immigrant populations and considers structural and intermediary social determinants of health while understanding the relationship with health outcomes.

Variables

<u>Outcome:</u> Systolic blood pressure was the main outcome and was measured at the time of the survey using the automated OMRON BP742N blood pressure monitor. Patients were seated for 5 minutes prior to obtaining the blood pressure reading based on guidelines for blood pressure measurement (AHA, 2018).

<u>Antecedents</u>:

<u>Region/Country of Origin:</u> Region and country of origin were assessed by asking the participant to choose their region of birth categorized into Europe/Canada, Central America/Mexico, Asia, and the Middle East/Africa.

<u>Ethnicity/Race:</u> Previously validated items from the National Health Behavioral Risk Factor Surveillance System (CDC BRFSS, 2014) were used to capture Hispanic ethnicity and four categories of race (Black/African American, White, Asian, Other).

<u>Life-course Socioeconomic Status (Life-course SES):</u> Life-course SES included the education level of the father, education level of the mother, size of family, birth order, and level of education (Wamala et al., 2001). Individuals who were born last, had more than three siblings, had less than a high school education, parents had less than a high school education, earned less than $25,000 per year, and were unemployed were each assigned one point, after which scores were summed for the individual to obtain a score of 0-7 with higher numbers indicating lower life-course SES.

<u>Predisposing Factors</u>:

Demographic Factors: Previously validated items from the National Health Behavioral Risk Factor Surveillance System (CDC BRFSS, 2014) were used to capture age, gender, marital status, education, occupation, and household income. Age was treated as a continuous variable, and household income was categorized into less than $25,000 and greater than or equal to $25,000. Education was categorized into less than or equal to high school graduate and college or higher.

Subjective Social Status (SSS): SSS is a perceived measure of socioeconomic status that independently predicts health outcomes (Cundiff et al., 2013). Respondents mark on a ladder with 10 rungs which rung they would place themselves if 10 are the people with the most money, education and well-respected job, and 1 are the people with the least money, education and well-respected jobs. The scale has clear convergent and discriminant validity after controlling for age and income (Cundiff et al., 2013).

Homelessness: History of homelessness was assessed using the segment Homeless History from the 1990 Course of Homelessness Study conducted by The Rand Corporation out of California (RAND, 2018). Three measures of homelessness were used including: homelessness with a parent as a child; homelessness without a parent as a child; and homelessness as an adult (18 years or older).

Border Community and Immigration Stress (BCIS): The BCIS is a 21-item validated scale that measures stressful experiences and migration pressures in foreign born individuals (Carvajal et al., 2013). Respondents were asked the degree to which they found various circumstances stressful as it relates to migration (Carvajal et al., 2013). The BCISS was found to have an alpha of 0.93, and variables were summed across categories to use as a continuous variable with higher scores indicating higher immigration stress.

Demand of Immigration (DI): The DI scale is a validated scale that measures distress related to migration and leaving friends and family behind (Ding et al., 2011). Respondents are asked to rate on a scale ranging from 1-Strongly Agree to 5-Strongly Disagree their dependence on and need of family who are currently located in their home country. This variable was also calculated using a summed score where the higher the score, the higher the demand of immigration.

Enabling Factors

Health Care Access: Previously validated items from the 2010 Medical Expenditure Panel Survey – Household Component (AHRQ, 2010) and Behavioral Risk Factor Surveillance System (CDC BRFSS, 2014) were used to capture having a usual source of care, visiting a primary care provider within the past year and having health insurance.

Perceived Discrimination: Previously validated items from the DISTANCE survey (Moffet et al., 2009) were used to capture perceived discrimination. Patients self-report on how often in the past 12 months they have felt they were treated poorly or made to feel inferior because of race/ethnicity, level of education, sex/gender, or language. Each of the four areas were treated as a binary variable and summed so that higher scores indicated higher perceived discrimination.

Perceived Stress: The perceived stress scale (PSS) is a 4-item scale that assesses the degree to which the respondent finds situations stressful (Cohen & Williamson, 1988). Responses range from "0" (never) to "4" (very often) and questions ask about the frequency of feelings related to events in the previous month (Cohen & Williamson, 1988). The Cronbach alpha value is 0.69 and high scores are highly correlated with stress, depression and anxiety (Andreou et al., 2011).

Health Literacy: Health literacy was measured by the 3-item Chew literacy scale (Chew et al., 2008). The scale measures respondents' capacity to obtain, process, and understand basic health-related decisions (Chew et al., 2008). The three items were summed so that higher scores indicate lower health literacy.

English Proficiency: The language subscale of the Marin and Marin Acculturation Scale was used to assess English proficiency. The measure is a previously validated scale that asks for the participant to indicate their primary or first language and asks 5 questions about preferred language use in personal life (Marin et al., 1987). Higher scores indicate higher English language proficiency.

Bicultural Self-Efficacy: Bicultural Self-Efficacy was assessed using a 26-item scale (David et al., 2009). The scale assesses social groundedness, communication ability, positive attitudes, knowledge, role repertoire, and bicultural beliefs, in foreign born individuals. Higher scores indicate higher self-efficacy.

Acculturation: The Marin and Marin Acculturation Scale assesses acculturation on three subscales (Language, Media, and Ethnic Social Relations) (Marin et al., 1987). Items are assessed using 5-point Likert scale and scores are summed to calculate acculturation score, with higher scores indicative of greater acculturation.

Need Factors

Disability: Disability was measured with the 8 previously validated items used by the Behavioral Risk Factor Surveillance System (CDC BRFSS, 2014) to capture health problems or impairments. Questions ask about limitations due to health, need for special equipment, and difficulty with tasks such as climbing stairs or going to the doctor office. The number of disabilities was summed to create a continuous measure.

Chronic Conditions: Previously validated items from the Behavioral Risk Factor Surveillance System (CDC BRFSS, 2014) were used to capture the existence of medically comorbid conditions. A continuous variable was created as a count the number of comorbidities reported.

Chronic Pain: Previously validated items from the Diabetes Study of Northern California (DISTANCE) survey (Moffet et al., 2009) were used to capture chronic pain and functional disability. Patients self-report on the amount of bodily pain including how much it interferes with sleep, whether the pain is present most of the time, and whether it has been discussed with a doctor. Responses to the 3 questions were summed for a final score with higher numbers indicating greater amount of pain.

Statistical Analysis

Statistical analysis was conducted with STATA version 14. Frequency, percent, means, and standard deviations were calculated and used to describe demographic factors for the sample. Pearson's correlation for the association between systolic blood pressure and antecedents, predisposing, enabling, and need factors were then calculated. To model the relationship between antecedents, predisposing, enabling, and need factors and blood pressure, the investigators elected to use three different regression approaches due to controversy around the best method to use in datasets with a large number of predictors. The first approach was a sequential model where each conceptual block (i.e. antecedents, predisposing, enabling, and need variables) were added as blocks and regressed against the outcome (systolic blood pressure) and variables were retained if they had a p-value of <=0.2. Then, significant variables from each of the block models were included in the final model. The second approach utilized stepwise regression with backward selection. For this approach stepwise regression was used to select variables for the

final model using a p-value of <=0.2 for retention in the model. Critics of stepwise regression argue that parameter estimates are biased, there are inconsistencies among model selection algorithms, and that there is an inappropriate reliance on a single best model (Whittingham et al., 2006). For the third approach, we used all possible subsets or best subsets regression (Hintze, 2007). This method compares all possible models using a specified set of possible predictors and then displays the best-fitting model that contain the pre-identified number of final predictors (Hintze, 2007). For this approach we compared pre-specified 5 and 7 variable final predictors using r-squared statistics and the pre-specified 7 variable final predictors yielded larger r-squared, so we used that model. After identifying the best all possible subset with 7 final variable predictors, we used multiple linear regression to assess their independent relationship with the outcome variable (systolic blood pressure). We compared r-squared values for each of the three approaches as well as consistency of final predictors selected by the three approaches and they were consistent.

Results

Demographic characteristics of the sample are shown in Table 1. The mean age was 45.4 years, with the majority being female (66.3%), not Hispanic/Latino (68%), insured (76.8%), and with a household income greater than or equal to $25,000 (57.5%). About 39.8% were born in Asia, 33.7% in Central America/Mexico, 14.4% in Europe/Canada, and 12.1% in the Middle East or Africa.

Correlations among the study variables are shown in Table 2. Age (r=0.34, p<0.001), disability (r=0.20, p=0.0001), comorbidities (r=0.30, p<0.001), and chronic pain (r=0.12, p=0.02) were found to be positively correlated with systolic blood pressure, and number of hours worked per week (r=-0.11, p=0.028) was negatively correlated with systolic blood pressure.

Table 3 shows results from the final models for the three different regression approaches. Using the first approach (sequential model adding conceptual variables in blocks), the final model found life-course SES (β=1.40, p=0.039), age (β=0.39, p<0.001), and male sex (β=13.62, p<0.001) to be positively associated with systolic blood pressure. Homelessness without a parent as a child trended towards significance (β=12.34, p=0.051). Using the second approach (stepwise regression with backward elimination), it was found that life-course SES (β=1.70, p=0.026), age (β=0.36, p<0.001), male sex (β=13.38, p<0.001), and homelessness without a parent as a child (β=13.14, p=0.034) were positively associated with systolic blood pressure. The final approach (all possible subsets regression) found that age (β=0.44, p<0.001), male sex (β=14.50, p<0.001), and homelessness without a parent as a child (β=14.08, p=0.027) were positively associated with systolic blood pressure.

Discussion

In this study of 181 immigrants in the midwestern United States, we found life-course SES, age, male sex, and being homeless without a parent as a child to be associated with increased systolic blood pressure. This is the first study to use a theory-based model that incorporates social determinants of health and immigrant specific factors, antecedents, predisposing, enabling, and need factors to examine the relationship between social determinants of health and blood pressure control in an immigrant population. These findings provide a better understanding of the relationship between social determinants of health and blood pressure among adult immigrants. We found consistent results using three different regression methods suggesting that beyond age and gender, which have been shown in prior studies, life-course SES and being homeless as a child are important factors that are significantly associated with increased systolic blood pressure in immigrants. These findings highlight the importance of

addressing social determinants of health specific to immigrant populations to improve health outcomes and identifies lower life-course SES and homelessness as a child as new potential areas for intervention in immigrant populations.

Life-course SES or the change in social mobility from parent to individual has been identified as an important factor to consider in immigrant health outcomes such as blood pressure (Akinyemiju et al., 2016). Research shows that immigrants are exposed to factors during childhood, prior to the migration process, during the migration process, and following migration that the majority of the native-born population do not have to face (Spallek et al., 2011). Prior to migration, immigrants have the potential to be exposed to factors such as civil unrest, terrorism, trauma, violence, endemic diseases or infections which may not be faced by native-born individuals of the new country (Spallek et al., 2011; Jamil et al., 2010). Immigrants are frequently exposed to stress associated with the migration process. Immigrant-specific factors for adults such as one's occupational status in the country of origin, disruption of social support, trauma, political involvement; and disruption of education, and separation from extended family and peer networks in the case of children are examples of pre-migratory stress immigrants may have been exposed to prior to arriving in the new or host country that may impact their health (Kirmayer et al., 2011). Additional research with diverse immigrant groups should be conducted that will increase understanding of the role of life-course SES on immigrant health.

Consistent with the literature, age and male sex were also found to be significantly positively associated with systolic blood pressure in immigrants (Howell, 1942; Pinto, 2007; Wen et al., 2015; Sandberg & Ji, 2012). However, homelessness is a factor that has not been closely examined among immigrant populations and is one that we have found to be significantly associated with systolic blood pressure in this group. Specifically, we identified being homeless as a child without a parent or guardian as a significant correlate of high systolic blood pressure in

adult immigrants. It is understood that immigrants are vulnerable to homelessness due to challenges that increase their likelihood of living in poverty (Gilleland et al., 2016). Unaccompanied minor immigrants have been found to be affected by war trauma and losses, have high levels of post-traumatic stress disorder, and high levels of psychological distress (Bean et al., 2006; Huemer et al., 2009; Fazel et al., 2012). It has also been found that experiencing sexual abuse, having witnessed the killing of parents, or being kidnapped was experienced more often among unaccompanied minors compared to accompanied minors (Huemer et al., 2009; Fazel et al., 2012). Additional research needs to be conducted to understand homelessness among immigrants, especially unaccompanied minors. The significance of this association indicates the need to consider this concept when designing interventions and studies that include an immigrant population.

The strengths of this study include the diverse immigrant sample, and utilization of three regression methods to minimize bias in the analyses. However, there are three limitations that should be considered when interpreting these findings. First, this was a cross-sectional study of immigrants, therefore inferences around causation should not be made. Secondly, the data that was analyzed was based on a midwestern sample, therefore the results may not generalize to immigrant groups in different parts of the US or around the world. Finally, the questionnaire was only available in English and Spanish, due to this limitation individuals who were unable to understand these languages were unable to participate in the study.

In conclusion, this study found an association between life-course SES, age, male sex, and being homeless as a child without a parent/guardian to be associated with systolic blood pressure in an immigrant sample. This study was based on a newly developed theoretical model that was specifically developed to better understand immigrant health. Additional research with diverse immigrant groups should be conducted that will increase understanding of the role of

life-course SES on immigrant health; and facilitate the development of new interventions targeted towards immigrants who may have at one point been an unaccompanied minor or homeless without a parent/guardian as a child.

Table 1. Sample characteristics

n = 181	Percent or Mean (Standard Deviation)
Age	
Mean Age	45.4 (16.6)
18 – 64	81.8%
65 - 94	18.2%
Sex	
Female	66.3%
Male	33.7%
Years of School	
Mean Years of School	14.3 (5.5)
≤ High School Graduate	32.8%
College/Graduate Education	67.2%
Employed	
Mean # of Hours Worked	24.9 (20.2)
No	42.5%
Yes	57.5%
Ethnicity - Hispanic or Latino	
No	68%
Yes	32%
Race	
White	32.6%
Black	11.6%
Asian	35.9%
Other	21.6%
Region of Birth	
Europe/Canada	14.4%
Central America/Mexico	33.7%
Asia	39.8%
Middle East/Africa	12.1%
Household Income	
≥ $25,000	57.5%
< $25,000	42.5%
Insured	
No	23.2%
Yes	76.8%

Table 2. Pearson's correlation for association between systolic blood pressure and antecedents, predisposing, enabling, and need factors

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Outcome																		
1. Systolic BP[a]	--																	
Antecedent																		
2. Lifecourse SES[b]	0.096	--																
Predisposing																		
3. Age	0.34***	0.12*	--															
4. Years of School	-0.097	-0.62***	-0.18***	--														
5. # of work hours/week	-0.11*	-0.36***	-0.41***	0.36***	--													
6. Income	-0.042	-0.59***	-0.086	0.58***	0.48***	--												
7. SSS[c]	-0.0037	-0.21***	0.081	0.14**	0.15**	0.25***	--											
8. Immigration Stress	-0.080	0.21**	-0.15*	-0.19*	-0.15*	-0.24**	-0.097	--										
9. Demand of Immigration	0.039	0.36***	0.11	-0.35***	-0.18*	-0.49***	-0.092	0.38***	--									
Enabling																		
10. PD[d]	-0.074	0.10	-0.25***	-0.042	0.076	-0.13*	-0.16**	0.33***	0.27***	--								
11. PS[e]	-0.0055	0.26***	-0.15**	-0.22***	-0.083	-0.35***	-0.23***	0.33***	0.46***	0.34***	--							
12. Health Literacy	-0.033	0.36***	-0.077	-0.36***	-0.18***	-0.36***	-0.12*	0.25***	0.37***	0.065	0.16**	--						
13. EP[f]	0.016	-0.36***	-0.19**	0.35***	0.31***	0.36***	0.072	-0.20**	-0.36***	0.082	-0.11	-0.30***	--					
14. BSE[g]	-0.058	-0.28***	-0.14	0.35***	0.39***	0.38***	-0.042	-0.18*	-0.51***	-0.029	-0.25***	-0.24**	0.35***	--				
15. Acculturation	0.039	-0.38***	-0.19**	0.40***	0.34***	0.41***	0.053	-0.24**	-0.37***	0.086	-0.10	-0.31***	0.91***	0.43***	--			
Need																		
16. Disability	0.20***	0.33***	0.30***	-0.38***	-0.43***	-0.47***	-0.20**	0.010	0.21**	0.093	0.22***	0.19***	-0.19*	-0.22**	-0.21**	--		
17. Comorbidities	0.30***	0.21***	0.53***	-0.25***	-0.44***	-0.30***	-0.14**	0.0017	0.16*	-0.079	0.057	0.013	-0.20**	-0.14	-0.20**	0.59***	--	
18. Chronic Pain	0.12*	0.18***	0.13**	-0.18***	-0.20***	-0.27***	-0.15**	0.16*	0.11	0.17**	0.26***	0.037	-0.052	0.0005	-0.027	0.54***	0.40***	--

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

a-systolic blood pressure; b-Life-course socioeconomic status; c-subjective social status; d-perceived discrimination; e-perceived stress; f-English proficiency; g-bicultural self-efficacy

Table 3. Sequential linear models for systolic blood pressure using three different approaches

	Approach 1	Approach 2	Approach 3
Adjusted R^2	0.35	0.37	0.40
Antecedents			
Life-course SES	1.40*	1.70*	1.23
Predisposing Factors			
Age	0.39***	0.36***	0.44***
Sex (Male)	13.62***	13.38***	14.50***
Married		3.26	2.57
Homeless as a child alone	12.34^a	13.14*	14.08*
Demand of immigration			-0.13
Enabling Factors			
Healthcare Access	1.79		
Perceived Discrimination			1.28
Health Literacy		-2.42	
Bicultural Self-Efficacy	-0.82		
Acculturation	2.28	1.86	
Need Factors			
Disability		1.40	
Comorbidities	0.090		

^{a} p=0.051; * p<0.05; ** p<0.01; ***p<0.001

Note: Approach 1 – Sequential model of each block first and only using significant
　　　　　　　variables from each block model at p<0.2 for final model
　　　Approach 2 – Stepwise regression with backward selection for sequential model
　　　Approach 3 – All possible subsets regression

Manuscript 2: Relationship between Latent Variables of Social Determinants of Health and Blood Pressure Control in United States Immigrants using Structural Equation Model

Abstract

This study used a theory-based model to identify latent variables for immigrant-specific social determinants of health (SDoH) using confirmatory factor analysis (CFA) and then structural equation modeling (SEM) to test theoretical validity and the relationship with systolic blood pressure (SBP) in adult immigrant sample in the midwestern United States in 2018. Pearson's correlation was used to assess the association between SBP and measured variables. CFA was used to identify latent variables for global socioeconomic status (SES), stressors of immigration, adaptation to immigration, acculturation, and burden of disease. SEM was used to test the structural relationships between each latent variable and SBP.

181 adult immigrants were included in the analysis. The initial model (chi2 (76, n=181) = 300.98, p<0.001, RMSEA = 0.086, CFI = 0.84, TLI = 0.78, CD = 0.98) showed that stressors of immigration were significantly related to SBP (r=-0.35, p=0.034). The final model (chi2 (68, n=181) = 149.87, p<0.001, RMSEA = 0.055, CFI = 0.94, TLI = 0.91, CD = 0.99) found burden of disease to be significantly related to SBP (r=0.35, p<0.001). Global SES, stressors of immigration, adaptation to immigration, and acculturation were not significant in the final model.

Based on theoretical relationships, one latent variable measuring need (burden of disease) was significantly associated with SBP in an adult immigrant sample. This suggests that interventions that target burden of disease are likely to be effective in controlling blood pressure in United States immigrants.

Introduction

Hypertension, or high blood pressure, is responsible for about 12.8% of all deaths around the world, and is a risk factor for coronary heart disease, heart failure, and ischemic and hemorrhagic stroke morbidity and mortality (WHO, 2018). The prevalence of hypertension ranges from 35-40% across the globe, with one out of three adults in the United States (US) diagnosed with hypertension, and only about 54% of these individuals having the condition under control (CDC, 2018). Individuals with hypertension spend about $2,000 more in medical expenditures compared to those without the disease, totaling over $130 billion annually in the US (Kirkland et al., 2018).

One of the populations most impacted by hypertension in the US are immigrants, whose risks for hypertension increases with length of residency (Commodore-Mensah et al., 2016; Salinas et al., 2014). Hypertension risk factors and the differences seen in native-born and immigrant populations have been addressed previously and attributed to genetic factors, biological factors and lifestyle factors (Brown et al., 2017; Zallman et al., 2013; Fang et al., 2018; Hall & Cuellar, 2016; Yi et al., 2016; Bamimore et al., 2012). However, there is limited work on the role of social determinants of health and blood pressure control in immigrant populations in the US. Social determinants of health are variables such as where people live, work, age, and are born that contribute to preventable health disparities (WHO, 2017; CDC, 2017). Immigrant-specific variables

that have been identified previously include: economic instability, lack of access to quality health care, limited English proficiency, fear related to immigration policies, perceived discrimination, stress, poor acculturation, limited bicultural self-efficacy, and high comorbidity and disability burden (Batalova & Alperin, 2018; Rosenthal, 2018; Shin et al., 2018; Commodore-Mensah et al., 2015; Luque et al., 2018; David et al., 2009). Building upon this body of evidence and previously described conceptual models (Andersen, 1995; Coyle & Battles, 1999; Yang & Hwang, 2016), we created a theory-based conceptual model for immigrant-specific social determinants variables and their relationship to clinical outcomes such as SBP (Figure 8). According to this model, immigrant-specific antecedents (region/country of origin, ethnicity/race, life-course socioeconomic status (SES)), predisposing (age, sex, education, employment, income, immigration stress, demand of immigration), enabling (perceived discrimination, perceived stress, health literacy, English proficiency, bicultural self-efficacy, acculturation) and need (disability, comorbidities, chronic pain) factors will be significantly associated with clinical outcomes such as blood pressure control.

Another limitation of current work in this area of research is the use of regression for most analyses. While regression is frequently used to identify relationships between independent and dependent variables like social determinants and blood pressure; regression is limited in that only measured variables can be included in the analysis (Bollen ,2002). This limitation does not allow for inclusion of latent constructs which may have greater explanatory power than a measured variable analyzed alone (Bollen, 2002; Kline, 2016). Confirmatory factor analysis (CFA) is a statistical method that allows researchers to test latent variables that explain the underlying constructs of a number of measured variables (Costello & Osborne, 2005). By using latent variables, it becomes

possible to take measurement error into account allowing for bias to be addressed when interpreting study findings (Schumacker et al., 2010). Similarly, structural equation modeling (SEM) combines latent variables with regression techniques to allow investigation of relationships between overarching latent constructs and measured outcomes, such as blood pressure (Kline, 2016).

Therefore, the aim of this study was to use a theory-based model to identify immigrant-specific latent constructs and use CFA to test theoretical validity of these constructs and then use SEM to test their relationship with systolic blood pressure in a population of adult immigrants residing in the Midwestern United States. We hypothesized that immigrant-specific social determinants of health latent variables (Figure 9) categorized as predisposing (global SES and stressors of immigration); enabling (adaptation to immigration and acculturation); need (burden of disease) would be theoretically valid and significantly associated with systolic blood pressure in an immigrant population.

Methods

Study Population

This was a cross-sectional study of 181 adult immigrants that was conducted in the Midwestern United States. Prior to starting enrollment procedures, the study protocol was reviewed and approved by the Medical College of Wisconsin Institutional Review Board (IRB). We defined immigrants as individuals who were born outside of the US and US territories. Immigrants who were at least 21 years of age or older were eligible to participate in the study. Individuals who exhibited signs of dementia, acute psychosis, or intoxication were deemed to be ineligible for the study. Multiple recruitment methods

were employed ranging from clinic-based, community-based, and snowball recruitment. Study participants were asked to complete a questionnaire that was made up of validated measures in English or Spanish in-person depending on language preference. Trained, bilingual members of the study team administered the survey in Spanish for Spanish-speaking individuals. Validated measures were used to capture antecedent, predisposing, enabling, and need social determinants of health. Blood pressure was measured by the study team using standard guidelines.

Conceptual Model

As noted previously, we created a theory-based conceptual model for immigrant-specific social determinants variables and their relationship to clinical outcomes (SBP) building upon prior evidence and previously described conceptual models (Andersen, 1995; Coyle & Battles, 1999; Yang & Hwang, 2016) (Figure 8). We then created latent variables that map to the constructs in the theoretical model (Figure 9).

Variables

Outcome: Systolic blood pressure was the primary outcome and was measured at the time of the survey using the automated OMRON BP742N blood pressure monitor. Patients were seated for 5 minutes prior to obtaining the blood pressure reading based on guidelines for blood pressure measurement (AHA, 2018).

Latent Variables: We created the latent variables based on our theoretical model as follows:

Predisposing Factors:

1**. Global Socioeconomic Status**: This was based on years of education, number of work hours and income. Validated items from the National Health Behavioral Risk Factor

Surveillance System (BRFSS) were used to capture years of education, work hours and household income (CDC BRFSS, 2014).

2. **Stressors of Immigration**: Variables used for this latent construct included life-course SES, immigration stress, and immigration demands. Life-course SES included measures that captured birth order, family size, and parents' education levels (Wamala et al., 2001). Individuals who were born last, had more than three siblings, had less than a high school education, parents had less than a high school education, earned less than $25,000 per year, and were unemployed were each assigned one point, after which scores were summed for the individual to obtain a score of 0-7 with higher numbers indicating lower life-course SES.

Border Community and Immigration Stress (BCIS): The BCIS is a 21-item validated scale that measures stressful experiences and migration pressures in foreign born individuals and has an alpha of 0.93 (Carvajal et al., 2013). Respondents were asked the degree to which they found various circumstances stressful as it relates to migration (Carvajal et al., 2013). Variables were summed across categories to use as a continuous variable with higher scores indicating higher immigration stress. Demand of Immigration (DI): The DI scale is a validated scale that measures distress related to migration and leaving friends and family behind (Ding et al., 2011). Respondents are asked to rate their dependence on and need of family who live in their home country on a scale ranging from 1-Strongly Agree to 5-Strongly Disagree. This variable was calculated using a summed score where higher the scores equal higher demand of immigration.

Enabling Factors

1. **Adaptation to Immigration**: Variables used for this latent construct included perceived discrimination, perceived stress and health literacy. Perceived Discrimination

(PD): PD was measured using previously validated items from the DISTANCE survey (Moffet et al., 2009). Patients self-report on how often in the past 12 months they have felt they were treated poorly or made to feel inferior because of race/ethnicity, level of education, sex/gender, or language. Each of the four areas were treated as a binary variable and summed so that higher scores indicated higher perceived discrimination.

Perceived Stress: The perceived stress scale (PSS) is a 4-item scale that assesses the degree to which the respondent finds situations stressful during the previous month (Cohen & Williamson, 1988). Responses range from "0" (never) to "4" (very often) (Cohen & Williamson, 1988). The Cronbach alpha value is 0.69 and high scores are highly correlated with stress, depression and anxiety (Andreou et al., 2011). Health Literacy: Health literacy was measured by the 3-item Chew literacy scale (Chew et al., 2008). The scale measures respondents' capacity to obtain, process, and understand basic health-related decisions (Chew et al., 2008). The three items were summed and indicate that higher scores equal lower health literacy.

2. Acculturation: Variables used for this latent construct included English proficiency, acculturation and bicultural self-efficacy. English Proficiency: The language subscale of the Marin and Marin Acculturation Scale was used to assess English proficiency. The measure is a previously validated scale that asks for the participant to indicate their primary or first language and asks 5 questions about preferred language use in personal life (Marin et al., 1987). Higher scores indicate higher English language proficiency.

Acculturation: The Marin and Marin Acculturation Scale assesses acculturation on three subscales (Language, Media, and Ethnic Social Relations) (Marin et al., 1987). Items are assessed using 5-point Likert scale and scores are summed to calculate acculturation score, with higher scores indicative of greater acculturation. Bicultural Self-Efficacy:

Bicultural Self-Efficacy was captured using a 26-item scale (David et al., 2009). The scale assesses social groundedness, communication ability, positive attitudes, knowledge, role repertoire, and bicultural beliefs, in foreign born individuals. Higher scores indicate higher self-efficacy.

Need Factors

1. Burden of Disease: Variables used for this latent construct included disability burden, comorbidities, and chronic pain. <u>Disability:</u> Disability was measured with 8 previously validated items from the Behavioral Risk Factor Surveillance System (CDC BRFSS, 2014) to capture health problems or impairments. Questions ask about limitations due to health, need for special equipment, and difficulty with tasks such as climbing stairs or going to the doctor office. The number of disabilities was summed to create a continuous measure. <u>Comorbidities:</u> Previously validated items from the Behavioral Risk Factor Surveillance System (CDC BRFSS, 2014) were used to capture the existence of 15 comorbid conditions including: (high blood pressure, high blood cholesterol, myocardial infarction, coronary heart disease, stroke, asthma, cancer, chronic obstructive pulmonary disease, arthritis, rheumatic diseases, depressive disorder, kidney disease, diabetes, HIV, Hepatitis C). A continuous variable was created as a count the number of comorbidities reported. <u>Chronic Pain:</u> Previously validated items from the DISTANCE survey (Moffet et al., 2009) were used to capture chronic pain and functional disability. Respondents used self-report to indicate the amount of bodily pain including how much it interferes with sleep, whether the pain is present most of the time, and whether it has been discussed with a doctor. Responses to the 3 questions were summed for a final score with higher numbers indicating greater amount of pain.

Statistical Analysis

Statistical analyses were performed with Stata version 14. First, we assessed means and percentages for sample demographic variables. Second, Pearson's correlations coefficients were estimated for the association between systolic blood pressure and measured variables used to create the latent constructs. Third, CFA was used to assess model fit for the latent variables, which were grouped into three categories: predisposing, enabling, and need according to the theory-based conceptual model for our analyses. CFA was used to determine which measured variables shared common variance and defined a theoretically sound construct or latent variable. Measures were retained if they loaded onto one factor, effectively explained the variance, and had factor loading greater than or equal to 0.6. After latent variables were created, CFA was used to determine if the variables were statistically significant. Once the model was finalized, modification indices were computed in Stata and used to improve the fit of each latent variable. Finally, SEM was used to test the structural relationships between each latent variable and systolic blood pressure. Goodness of fit indices including model chi2, RMSEA, pclose, CFI, TLI and CD were used to assess the goodness of fit of the final model based upon established cut-points for the indices as well as consistency across indices (Hooper et al., 2008; Cangur & Ercan, 2015; Hu & Bentler, 1999). We used RMSEA <0.06, pclose non-significant, CFI/TLI >0.9 and CD >0.9 as cut-points for goodness of fit.

Results

Table 1 shows the demographic and sample characteristics for this sample of 181 adult immigrants. The majority of the participants were female, had a mean age of 45

years, 14 years of education, and about 57% were employed. About 35.4 % were non-Hispanic Asian, 33.7% were born in Central America/Mexico, 42.5% had an annual household income of less than $25,000, and about 76.8% were insured.

Table 2 shows correlations among the study variables. The number of hours worked per week (r=-0.11, p=0.028) was found to be negatively correlated with systolic blood pressure. Chronic pain (r=0.12, p=0.02), comorbidities (r=0.30, p<0.001), disability (r=0.20, p=0.0001), and age (r=0.34, p<0.001) were found to be positively correlated with systolic blood pressure.

Test of Latent Variables in the Model

Based on a review of the literature for important immigrant specific constructs, we hypothesized predisposing latent variables of global SES and stressors of immigration, enabling latent variables of adaptation to immigration and acculturation, and the need latent variable of burden of disease to have a relationship with systolic blood pressure (Figure 9). Table 4 shows the loading for each item onto the identified factor.

Latent variable for global socioeconomic status

Confirmatory factor analysis was used to assess the measurement properties of the global SES latent variable. The measured variables included years of education, the number of hours worked per week, and income. The measured variables loaded onto the factor with factor loadings ranging from 0.54 – 0.89. Each item loaded significantly at the p<0.001 level for the factor.

Latent variable for stressors of immigration

The measured variables that were used to develop stressors of immigration latent variable included life-course SES, immigration stress, and demand of immigration. Factor loading ranged from 0.40 – 0.80 for the variables, and each item loaded significantly at the $p<0.001$ level for the factor.

Latent variable for adaptation to immigration

Perceived discrimination, perceived stress, and health literacy measures were used to create the adaptation to immigration latent variables. Loading for each item onto the identified factor ranged from 0.17 – 0.91. Each item loaded significantly at the $p<0.001$ level for the factor.

Latent variable for acculturation

Two measures were used to develop the acculturation latent variable, Marin and Marin acculturation and bicultural self-efficacy. Each item loaded significantly at the $p<0.001$ level for factor loading and loadings ranged from 0.43 – 0.99 for the factor.

Latent variable for burden of disease

Disability, comorbidity, and chronic pain were used to develop the burden of disease latent variable. Loading for each item ranged between 0.61 – 0.89 and was significant at the $p<0.001$ level.

Structural Model

Figure 9 shows the theoretical relationships that were tested in the initial model. This initial model (chi2 (76, n=181) = 300.98, p<0.001, RMSEA = 0.086, CFI = 0.84, TLI = 0.78, CD = 0.98) showed that stressors of immigration had a significant negative association with systolic blood pressure (r=-0.35, p=0.034); and burden of disease trended towards significance (r=0.22, p=0.061). Global SES, adaptation to immigration, and acculturation were not significantly related to systolic blood pressure. The goodness of fit statistics suggested that the model could be improved therefore modification indices were used to identify appropriate variables to covary in the analysis. The final model (Figure 10) had improved model fit (chi2 (68, n=181) = 149.87, p<0.001, RMSEA = 0.055, CFI = 0.94, TLI = 0.91, CD = 0.99) and found burden of disease to have a significant positive relationship with systolic blood pressure (r=0.35, p<0.001). Global SES, stressors of immigration, adaptation to immigration, and acculturation were not significant in the model.

Discussion

Using a theory-based conceptual model we were able to identify key latent constructs specific to immigrant health and successfully created five latent variables to represent predisposing, enabling, and need factors. After using multiple measured variables, we found that only three items were necessary to create a latent variable for global SES, stressors of immigration, adaptation to immigration and burden of disease; and two items were used to create the acculturation latent variables. Structural equation modeling showed that the need construct of burden of disease latent variable had a significant positive association with systolic blood pressure. These results are in line with

previously identified health services research models developed by Andersen, and Yang and Hwang (Andersen, 1995; Yang & Hwang, 2016).

The disease burden latent variable included measures of disability, number of comorbidities, and chronic pain. All of which are mutable factors that need to be considered for this immigrant population. The Andersen model that was published in 1995 (Andersen, 1995) identified need as an important factor and our results not only support this finding but also suggest the importance of considering need variables of comorbidity, disability, and pain when trying to address hypertension in immigrant groups. We were able to successfully start with a theory-based conceptual model, identify items that hung well together and achieved appropriate factor loading, and with that were able to create a parsimonious model that allowed us to test the relationship between latent variables and systolic blood pressure in an adult immigrant sample. We learned that even though immigrant specific factors are important to consider, the key driver of blood pressure in this population remained need factors, which we identified as burden of disease using latent variable analysis or CFA. These results are in accordance with research that focuses on identification of drivers for health services utilization and outcomes (Andersen, 1995; Yang & Hwang, 2016; Li et al., 2016; Wong et al., 2007).

Our study is novel and significant for several reasons. This is the first time a theory-based approach has been identified using Andersen's predisposing, enabling, and need factors health services research model. Second, latent constructs that are unique to immigrants were identified based on literature review and guided the creation of latent variables unique to immigrant health. Third, we included variables that have been shown to be important for both US-born and immigrant groups. Fourth, our study provides a new way of analyzing data and identifying potential targets for intervention development

for immigrants. Fifth, our findings set the stage for more focused efforts to use novel approaches to explore the relationship between predictors and outcomes in populations with cardiovascular disease, especially in immigrant populations. Finally, this study is a good starting point for other researchers who are interested in creating latent variables and identifies parsimonious constructs that are likely to generalize to other immigrant populations and across diseases. However, further research is needed to validate our conceptual framework.

Our study has two main limitations. First, due to the cross-sectional study design we are unable to make assumptions regarding causation or directionality of the findings identified. Second, the study was conducted in the Midwest United States and therefore our results may not be generalizable to other regions.

In conclusion, using a theory-based model we were able to successfully identify two predisposing, two enabling, and one need latent variable; and to test these relationships with systolic blood pressure in an adult immigrant sample residing in the Midwestern US. We found the need latent variable of disease burden to be significantly positively associated with systolic blood pressure. Our findings highlight the need for the utilization of novel data analysis methods and may serve as the foundation for future health services research focusing on disease burden in immigrant populations. Additional research on diverse immigrant groups is needed to identify key drivers of blood pressure that will inform the development of interventions to address cardiovascular disease in this vulnerable group.

Table 4. Model fit for individual latent variables in midwestern immigrant sample, 2018

Latent Variable	Items	Loading
Predisposing		
Global Socioeconomic Status (PGSES)	Years of Education	0.66
	Number of Hours Worked per Week	0.54
	Income	0.89
Stressors of Immigration (PDEMAND)	Life-course SES	0.40
	Immigration Stress	0.46
	Demand of Immigration	0.80
Enabling		
Adaptation to Immigration (EADAPT)	Perceived Discrimination	0.38
	Perceived Stress	0.91
	Health Literacy	0.17
Acculturation (EACCUL)	Marin and Marin Acculturation	0.99
	Bicultural Self-Efficacy	0.43
Need		
Burden of Disease (NBURDEN)	Disability	0.89
	Comorbidity	0.66
	Chronic Pain	0.61
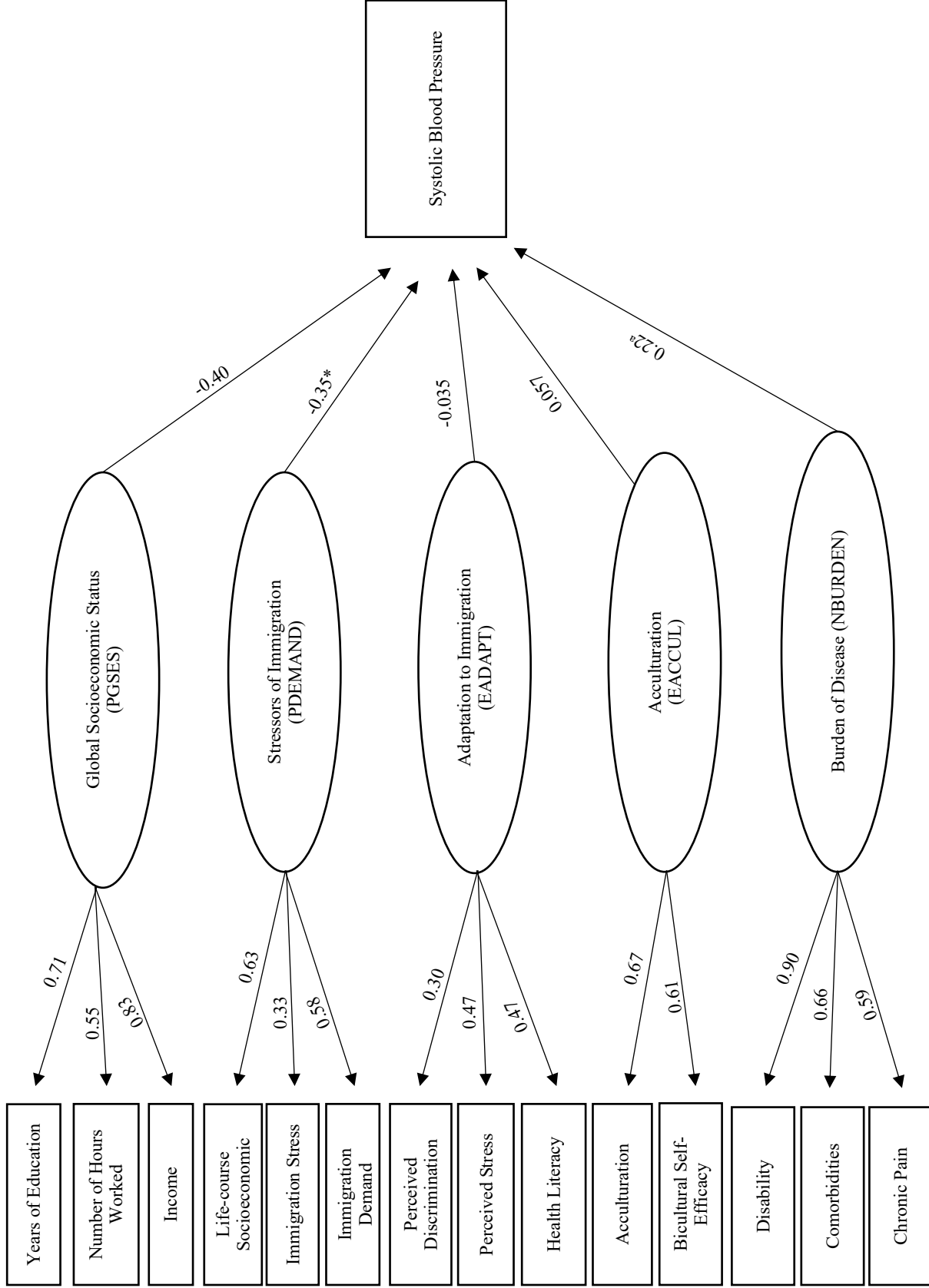
Figure 9. Initial immigrant specific social determinants of systolic blood pressure model. Note: coefficients are standardized path coefficients. Overall model fit chi2 (76, n=181) = 300.98, p<0.001, RMSEA = 0.086, CFI = 0.84, TLI = 0.78, CD = 0.98. All factor loadings significant at p <0.001. For paths *p<0.05, a=0.061.
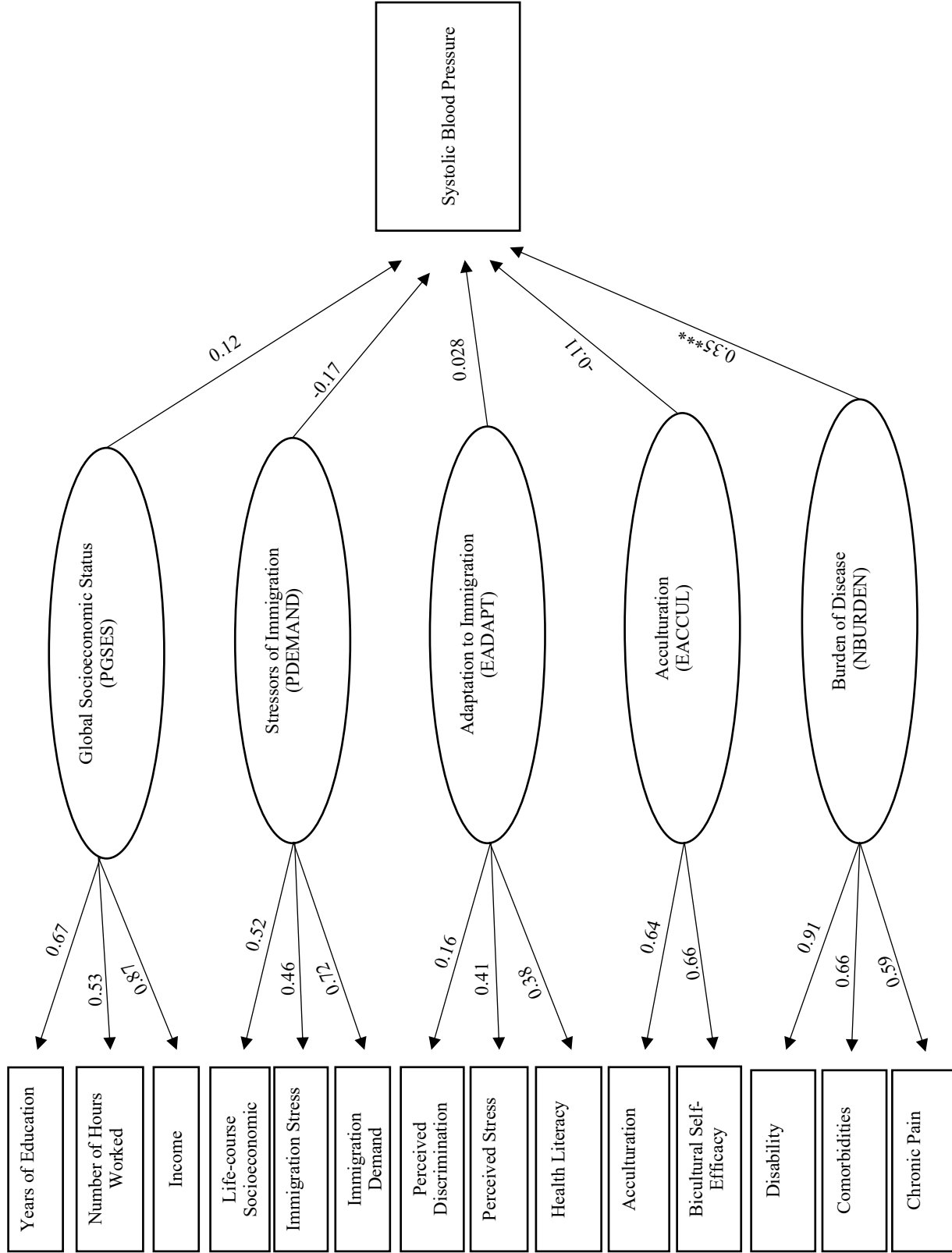
Figure 10. Final immigrant specific social determinants of systolic blood pressure model. Note: coefficients are standardized path coefficients. Overall model fit chi2 (68, n=181) = 149.87, p<0.001, RMSEA = 0.055, CFI = 0.94, TLI = 0.91, CD = 0.99. All factor loadings significant at p <0.001. For paths ***p<0.001.

Manuscript 3: Quantifying Direct Effects of Social Determinants of Health on Systolic Blood Pressure in United States Adult Immigrants

Abstract

Objective: Identify the pathway by which social determinants of health (SDoH) variables impact systolic blood pressure (SBP) in immigrants.

Methods: Latent variables were used to assess the relationship between SDoH and SBP. Latent variables were identified using confirmatory factor analysis (CFA) for 1) global socioeconomic status (SES) (education, income, number of hours worked per week), 2) stressors of immigration (life-course SES, immigration stress, immigration demand), 3) adaptation to immigration (perceived discrimination, perceived stress, health literacy), and 4) burden of disease (disability, comorbidities, chronic pain). Structural equation modeling (SEM) was used to investigate the relationship between immigrant specific latent variables and SBP.

Results: The study included 181 adult immigrants. The initial model (chi2 (77, n=181) = 302.40, p<0.001, RMSEA = 0.086, CFI = 0.84, TLI = 0.78, CD = 0.91) showed that stressors of immigration had a direct relationship with SBP (-0.35, p=0.033); global (SES) had a direct relationship with burden of disease (-0.70, p=0.007) and an indirect relationship with SBP by way of burden of disease (0.24, p=0.015). The final model (chi2 (69, n=181) = 149.98, p<0.001, RMSEA = 0.054, CFI = 0.94, TLI = 0.91, CD = 0.96) maintained that global SES had a direct relationship with burden of disease (-0.40, p<0.001) and an indirect relationship with SBP by way burden of disease (0.34, p<0.001).

Conclusions: This study suggests a direct relationship between burden of disease and SBP, and an indirect relationship between SES and SBP. Development of interventions should take burden of disease into account as a direct driver of blood pressure in immigrants, and address factors related to SES.

Introduction

Hypertension or high blood pressure is a key risk factor for cardiovascular disease (CVD) (WHO, 2013). Hypertension is highly prevalent with more than 1 billion people having the disease (WHO, 2013; Mills et al., 2016), and is associated with increased mortality and morbidity, accounting for about 9.4 million deaths worldwide. Additionally, high blood pressure is responsible for about 45% of deaths due to heart disease and about 51% of deaths due to stroke (WHO, 2013; Mills et al., 2016). The direct costs of hypertension are expected to increase from the 2010 estimate of about $70 billion to $200 billion and indirect costs due to loss of productivity are expected to increase from about $23 billion to $40 billion by 2030 (Wang et al., 2017; Heidenreich et al., 2011).

The prevalence of self-reported hypertension is higher in foreign-born individuals than in US-born (Yi et al., 2014). A study by Yi et al found that foreign-born Blacks, Hispanics, and Asians had 75%, 40%, and 31% increased odds of reporting hypertension respectively compared to US-born Whites (Yi et al., 2014). Foreign-born individuals are also less likely to have insurance and are less likely to be aware of having hypertension compared to US-born individuals (Cole et al., 2018; Commodore-Mensah et al., 2015). Research shows that obesity, length of residence, and acculturation may be related to hypertension in immigrants with negative changes in diet and exercise patterns increasing over time (Kaplan et al., 2004; Goel et al., 2004; Brown et al., 2017). Immigrants have

also been found to have lower income, lower levels of education, poorer access to care, and are less likely to discuss diet and exercise with a clinician compared to those born in the US (Goel et al., 2004).

These findings highlight the need to closely examine social determinants of health, or the conditions in which people are born, grow, live, work and age, to better understand their role on hypertension in immigrant groups (Marmot & Wilkinson, 2006; WHO, 2010). Immigrant-specific factors such as inability to obtain insurance due to documentation status, fear of deportation, or other stressors not experienced by the native-born population may be drivers in the relationship between SDoH and hypertension (Cole et al., 2018; Kaushal & Kaestner, 2005; ACA, 2010). For example, one study found income and education was associated with hypertension in African Americans, while having health insurance was associated with hypertension in foreign-born Blacks (Commodore-Mensah et al., 2018). Immigrant-specific SDoH can be categorized in terms of antecedents, predisposing, enabling, and need factors as illustrated by previous health services research models. While there is no single model that includes all of these components, models proposed by Andersen, Coyle and Battles, and Yang and Hwang consists of some of each of these factors (Andersen, 1995; Coyle and Battles, 1999; Yang & Hwang, 2016). As far as we know, no single model has tested the relationships in immigrant populations between antecedents, predisposing, enabling and need factors and SBP.

Therefore, we developed a theory-based conceptual model that includes immigrant-specific factors (Figure 11) and we aimed to identify the pathway by which social determinants of health (SDoH) variables impact systolic blood pressure (SBP) in immigrants. By using structural equation modeling (SEM) we sought to identify direct

and indirect relationships, and increase our understanding of possible interventions to improve outcomes. We hypothesized that our pre-identified immigrant-specific latent variables would have direct and indirect effects on systolic blood pressure and burden of disease in adult immigrants residing in the Midwestern United States.

Methods

Study Population

The protocol and study procedures were approved by the Institutional Review Board (IRB) at the Medical College of Wisconsin (MCW) prior to initiating study recruitment and enrollment. One hundred eighty-one (181) adult immigrants participated in this cross-sectional study. Inclusion criteria were immigrants or anyone who was born outside of the United States and its territories, and individuals at least 21 years of age or older. Individuals were excluded if signs of intoxication, dementia, or acute psychoses were exhibited. Members of the study team were trained in survey research and included two English/Spanish bilingual individuals. Participants were recruited using snowball, community-based, and clinic-based recruitment methods. Study participants were asked to complete a questionnaire in English or Spanish that was made up of validated measures of social determinants of health. The study team read the questionnaire aloud in a private setting for individuals who had difficulty seeing, reading, or writing. The validated measures were used to capture social determinants of health in terms of antecedents, predisposing, enabling, and need factors.

Conceptual Model

Latent variables that were previously identified based on a theory-based conceptual model (figure 8) were included in the analysis to assess their relationship with SBP and need latent factor burden of disease. Measures used to create each latent variable are described below. Two predisposing latent variables were identified 1) global socioeconomic status (SES) that included measures of education, income, and number of hours worked per week; and 2) stressors of immigration that included measures of life-course SES, immigration stress, and immigration demand. One enabling latent variable was identified that included adaptation to immigration included measures of perceived discrimination, perceived stress, and health literacy. Finally, one need latent variable of burden of disease was identified that included measures of disability, comorbidities, and chronic pain.

Variables

Outcome - Systolic Blood Pressure (SBP): Study participants were seated for five minutes according to American Heart Association guidelines prior to obtaining blood pressure measurement (AHA, 2018). Systolic blood pressure was measured using the OMRON BP742N blood pressure monitor by study team members at the time of the survey.

Latent Variables

Predisposing Factors:

1.   **Global Socioeconomic Status (SES):** This variable included measures of income, education, and the number of hours worked weekly. The National Health

Behavioral Risk Factor Surveillance System (BRFSS) has validated items for income, education, and work hours that were used in the questionnaire.

2. **Stressors of Immigration:** This was based on life-course SES, immigration stress, and immigration demands.

Life-course SES: Parental level of education, birth order, and family size were incorporated into a measure of life-course SES as identified previously in the literature (Wamala et al., 2001). Scores range between 0 – 7 with higher numbers indicating lower life-course SES. Those who were born last, had more than three siblings, less than high school education, earned less than $25,000 per year, were unemployed, and whose parents had less than a high school education were assigned one point, and scores were summed.

Border Community and Immigration Stress (BCIS): The BCIS is a 21 item scale that has an alpha of 0.93 and measures stressful experiences and migration challenges in immigrants (Carvajal et al., 2013). Participants are asked the degree to which they find situations related to migration stressful. The variables are summed across categories and the measure is used as a continuous variable with higher scores indicating higher immigration stress (Carvajal et al., 2013).

Demand of Immigration (DI): The DI scale allows respondents to rate their dependence on and need of family who live in the home country from 1 (strongly agree) to 5 (strongly disagree). This is a validated scale that measures distress related to migration and leaving friends and family behind (Ding et al., 2011). Higher scores indicate higher demand of immigration.

Enabling Factors:

1. **<u>Adaptation to Immigration:</u>** This factor was based on perceived discrimination, perceived stress, and health literacy.

   <u>Perceived Discrimination (PD):</u> Perceived discrimination was captured using the validated scale from the DISTANCE survey (Moffet et al., 2009). Individuals responded to items that asked how often in the past 12 months have they felt they were treated poorly or made to feel inferior because of race/ethnicity, level of education, sex/gender, or language. Each of the four areas were treated as a binary variable and summed so that higher scores indicated higher perceived discrimination.

   <u>Perceived Stress:</u> The perceived stress scale (PSS) has an alpha of 0.69 and is a 4-item scale that assesses the degree to which the respondent finds situations stressful during the previous month (Cohen & Williamson, 1988; Andreou et al., 2011). Responses range from "0" (never) to "4" (very often) (Cohen & Williamson, 1988). High scores on the PSS have been found to be highly correlated with stress, depression and anxiety (Andreou et al., 2011).

   <u>Health Literacy:</u> Health literacy was measured by the 3-item Chew literacy scale (Chew et al., 2008). The scale measures respondents' capacity to obtain, process, and understand basic health-related decisions (Chew et al., 2008). The three items were summed and indicate that higher scores equal lower health literacy.

Need Factors:

1. **<u>Burden of Disease:</u>** This factor was based on disability burden, comorbidities, and chronic pain.

Disability: Eight previously validated items from the National Health Behavioral

Risk Factor Surveillance System (BRFSS) that asked questions about limitations

due to health, need for special equipment, and difficulty with tasks such as

climbing stairs or going to the doctor office were used to capture health problems

or impairments (CDC BRFSS, 2014). A continuous measure was created by

summing the number of disabilities.

Comorbidities: A continuous variable was created as a count of the number of

comorbid conditions that were reported using previously validated items from the

Behavioral Risk Factor Surveillance System (BRFSS, 2014). These items were

used to capture the existence of 15 comorbid conditions including: (high blood

pressure, high blood cholesterol, myocardial infarction, coronary heart disease,

stroke, asthma, cancer, chronic obstructive pulmonary disease, arthritis, rheumatic

diseases, depressive disorder, kidney disease, diabetes, HIV, Hepatitis C).

Chronic Pain: Chronic pain was captured by using previously validated items

from the DISTANCE survey (Moffet et al., 2009). Study participants were asked

to indicate amount of bodily pain, how much pain interferes with sleep, whether

pain is present most of the time, and whether the individual discussed pain with a

doctor. The three responses were summed and a higher value indicated a greater

amount of pain.

Statistical Analysis

Stata version 14 was used to perform statistical analyses with a p<0.05 used to

indicate statistical significance. First, descriptive statistics of mean, percent, and

frequency were calculated to describe the sample. Second, Pearson's correlation

coefficients were calculated for the association between systolic blood pressure and variables within each latent variable: global SES (years of school, number of work hours per week, income), stressors of immigration (life-course SES, immigration stress, health literacy), adaptation to immigration (perceived discrimination, perceived stress, health literacy), and burden of disease (disability, comorbidity, chronic pain). Third, CFA was used to create the latent variables (global SES, stressors of immigration, adaptation to immigration, and burden of disease).

Finally, these latent variables were then used in the SEM models to investigate the relationship among immigrant specific determinants of health in the context of predisposing, enabling, and need latent variables and systolic blood pressure. Structural equation modeling (SEM) is a methodology that allows for the analysis of multiple dependent and multiple independent variables at one time, allows for the inclusion of unobserved or latent constructs, and the specification of indirect effects (Kline, 2016; Pearl, 2001; Bollen & Stine, 1990). We hypothesized that predisposing (global SES and stressors of immigration), enabling (adaptation to immigration), and need (burden of disease) latent variables would have a direct relationship with SBP, and that predisposing and enabling latent variables would have an indirect relationship with SBP by way of the need latent variable. All analyses were completed with standardized estimates due to the variety of scales that were utilized (Sánchez et al., 2005). Standardized estimates are interpreted as the change in standard deviation in SBP due to a one standard deviation increase in the predictors (Sánchez et al., 2005). We used established cut-points for a number of goodness of fit statistics to determine model fit, including: RMSEA <0.06, non-significant pclose, CFI/TLI greater than 0.9, and CD greater than 0.9 (Hooper et al., 2008; Cangur & Ercan, 2015; Hu & Bentler, 1999).

Results

      The demographic characteristics for this sample of 181 adults US immigrants are shown in Table 1. The mean age was 45 years, with the majority being female (66.3%), not Hispanic/Latino (68%), having a household annual income greater than or equal to $25,000 (57.5%), and being insured (76.8%). About 36% were Asian and about 12% reported that were born in the Middle East/Africa.

      Table 5 shows correlations for the association between systolic blood pressure and variables within each latent variable. We found systolic blood pressure to be significantly associated with predisposing measure of life-course SES (0.15, p=0.045), need measures of disability (0.23, p=0.0024), and comorbidity (0.30, p=0.0001).

Latent Variables

      Confirmatory factor analysis (CFA) was used to assess the measurement properties of four latent variable. A latent variable for the predisposing factor of Global SES used three measured variables (years of school, number of work hours/week, and income). The variables loaded onto one factor with loadings ranging from 0.55 – 0.83. All loadings were significant at p<0.001. CFA assessed the measurement properties of the stressors of immigration predisposing latent variable using life-course SES, immigration stress, and immigration demand. Factor loadings ranged from 0.33 – 0.63 and all were significant at the p<0.001 level. CFA assessed the measurement properties of the adaptation to immigration enabling latent variable using perceived discrimination, perceived stress, and health literacy. Factor loadings ranged from 0.29 – 0.47. Each item loaded significantly at the p<0.001 level for the factor. CFA assessed the measurement

properties of the burden of disease need latent variable using disability, comorbidities, and chronic pain. Factor loadings ranged from 0.59 – 0.90 and all were significant at the p<0.001 level.

Structural Models

Figure 12 shows the initial model with direct and indirect effects. In this model, (chi2 (77, n=181) = 302.40, p<0.001, RMSEA = 0.086, CFI = 0.84, TLI = 0.78, CD = 0.91) stressors of immigration had a significant negative direct relationship with SBP (-0.35, p=0.033); global SES had a significant negative direct relationship with burden of disease (-0.70, p=0.007) and a significant indirect relationship with systolic blood pressure by way of burden of disease (0.24, p=0.015). Modification indices were used to identify ways to improve model fit. After covarying select recommended variables, the final model was produced (figure 13). The final model had improved fit statistics (chi2 (69, n=181) = 149.98, p<0.001, RMSEA = 0.054, CFI = 0.94, TLI = 0.91, CD = 0.96) and maintained that global SES has a direct relationship with burden of disease (-0.40, p<0.001) and an indirect relationship with systolic blood pressure by way burden of disease (0.34, p<0.001); the initial relationship seen with stressors of immigration and systolic blood pressure was no longer significant.

Table 6 shows the direct, indirect, and total effects for the final model (figure 13). Burden of disease was shown to have a significant direct effect with SBP (0.34, p<0.001), and global SES was shown to have a significant negative indirect effect with SBP (-0.14, p=0.006). Global SES had a significant negative direct effect with burden of disease (-0.40, p=0.001), and a significant negative indirect effect with disability (-0.36, p=0.001), comorbidities (-0.26, p=0.001), and chronic pain (-0.24, p=0.001). Burden of

disease had significant positive direct effects with disability (0.91, p<0.001),

comorbidities (0.66, p<0.001) and chronic pain (0.59, p<0.001).

Discussion

Using structural equation modeling and a theory-based conceptual model, we

identified pathways between immigrant-specific latent variables and SBP. We found that

global SES (years of education, number of hours worker, income) has a direct negative

relationship with burden of disease (disability, comorbidity, chronic pain), and an indirect

relationship with systolic blood pressure by way of burden of disease in an adult

immigrant sample. Additionally, burden of disease had a significant positive direct

relationship with systolic blood pressure.

This study is novel because it is the first time that immigrant specific SDoH latent

constructs were identified using a theory-based framework to investigate direct and

indirect effects on SBP. Since SEM allows for the analysis of multiple dependent and

independent variables at once, and provides a means of identifying direct and indirect

pathways, it provides a more comprehensive understanding of the relationship between

variables included in the model and ideas for future research directions. The significant

direct pathway between disease burden and systolic blood pressure suggests that

interventions developed to address disease burden, specifically disability, comorbidities,

and managing chronic pain, may show promise in improving hypertension outcomes in

adult US immigrants. In addition, the significant indirect pathway through global SES to

systolic blood pressure, suggests that to address the health of immigrants it will be

important to consider socioeconomic status in intervention design. Interventions focused

on enhancing education, providing job or skills training to improve employment

opportunities and earning potential could be considered when working with immigrant groups.

While we hypothesized that immigrant specific factors such as stressors of immigration and adaptation to immigration would be significant indicators of health outcomes, our results did not show a significant relationship with systolic blood pressure. The significant pathways, however, are consistent with the literature identifying burden of disease and SES as important factors in the relationship with health outcomes, specifically hypertension (Andersen, 1995; Coyle & Battles, 1999; Cois & Ehrlich, 2014; Taherian et al., 2018). It is also important to note that the direct pathway from global SES to disease burden is consistent with existing social determinants literature that indicate structural determinants such as education, employment, and income are key determinants for disease burden or disability, comorbidities, and chronic pain (WHO, 2010; Marmot, 2006). Income, education, and occupation have been found to have strong relationships with health (WHO, 2010).

While strengths of this study include the utilization of novel methodology and theory-based framework, there are three main limitations that should be noted. First, due to the relatively small sample size we were not able to test additional pathways. Second, this was a cross-sectional study and causality may not be inferred from the results presented. Third, the study was conducted among a sample of immigrants residing in the Midwestern US, and the results may not be generalizable to immigrant groups in other regions of the country.

Conclusions

In conclusion, this study found a direct relationship between burden of disease and systolic blood pressure, a direct relationship between global SES and burden of disease, and an indirect relationship between global SES and systolic blood pressure by way of burden of disease in adult immigrants residing in the Midwestern United States. The results support existing literature that identifies SES and need factors as key drivers of health, and provide novelty by using methodology that allows for testing of direct and indirect pathways. Based on these findings, interventions developed to address hypertension for immigrant groups should focus on reducing the burden of disease through decreasing disability, improving pain management or treating comorbidities, and should incorporate components to address SES through educational programs or job training in an effort to decrease hypertension.

Figure 11. Theory-based conceptual model for immigrant social determinants of health outcomes
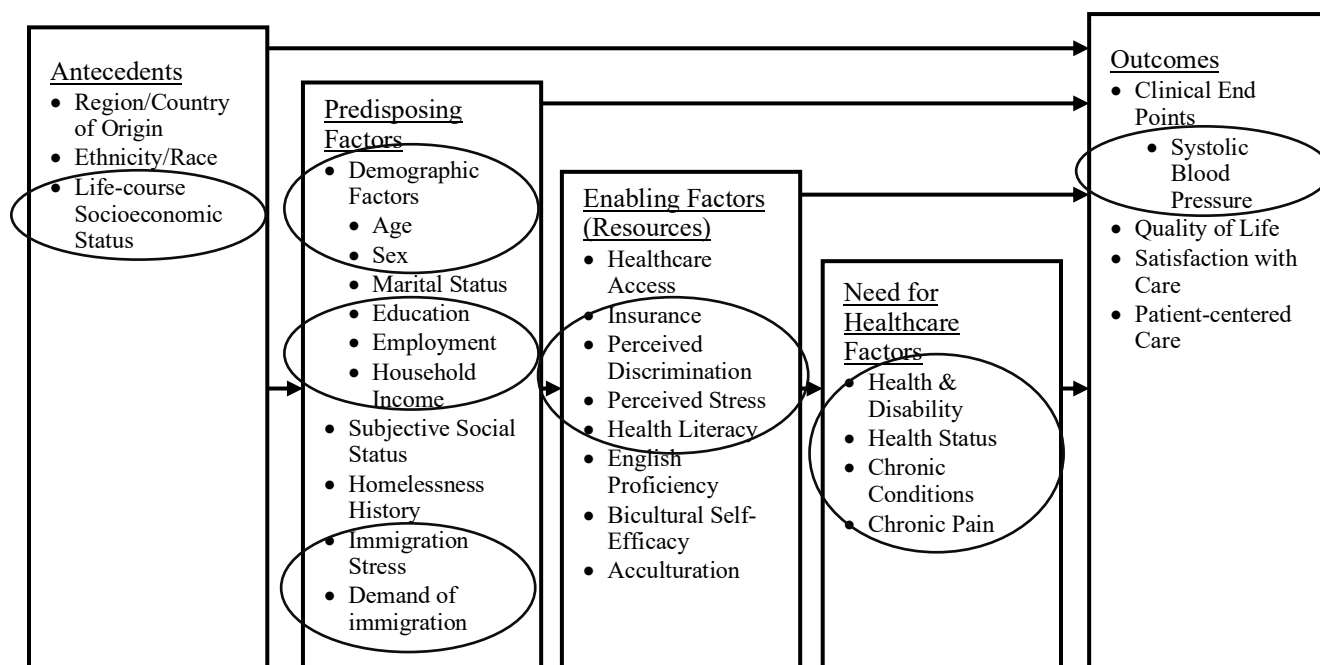
Table 5. Pearson's correlation for association between systolic blood pressure and variables within each latent variable

	Correlation Coefficient
Predisposing – Global Socioeconomic Status	
Years of School	-0.095
Number of work hours/week	-0.084
Income	-0.046
Predisposing – Stressors of Immigration	
Life-course Socioeconomic Status	0.15*
Immigration Stress	-0.080
Demand of Immigration	0.039
Enabling – Adaptation to Immigration	
Perceived Discrimination	-0.0065
Perceived Stress	0.0047
Health Literacy	-0.050
Need – Burden of Disease	
Disability	0.23**
Comorbidity	0.30***
Chronic Pain	0.080

* $p<0.05$; ** $p<0.01$; ***$p<0.001$
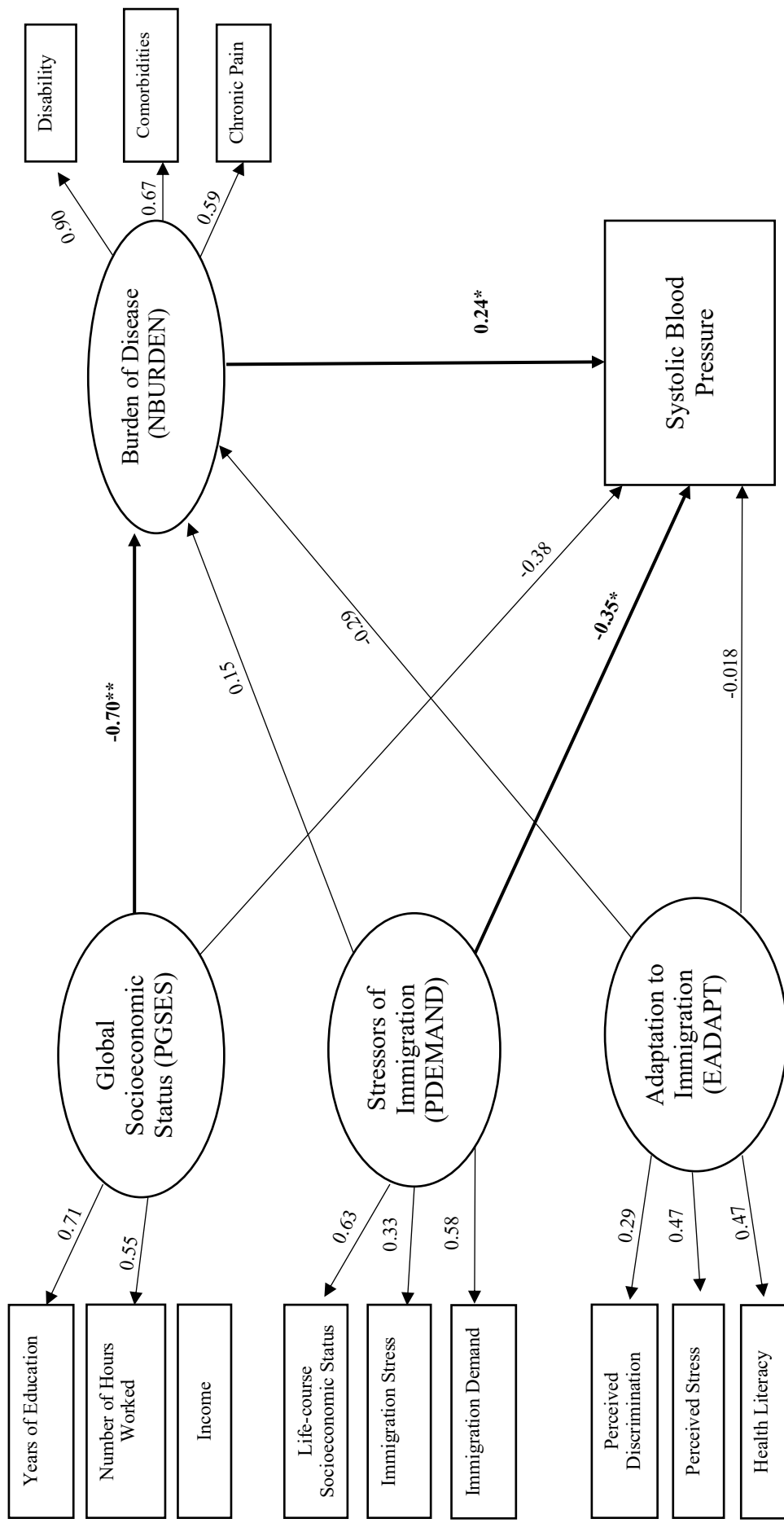
Figure 12. Base model with direct and indirect effects. Note: coefficients are standardized path coefficients. Overall model fit chi2 (77, n=181) = 302.40, p<0.001, RMSEA = 0.086, CFI = 0.84, TLI = 0.78, CD = 0.91. All factor loadings significant at p <0.001. For paths *p<0.05; **p<0.01; ***p<0.001.
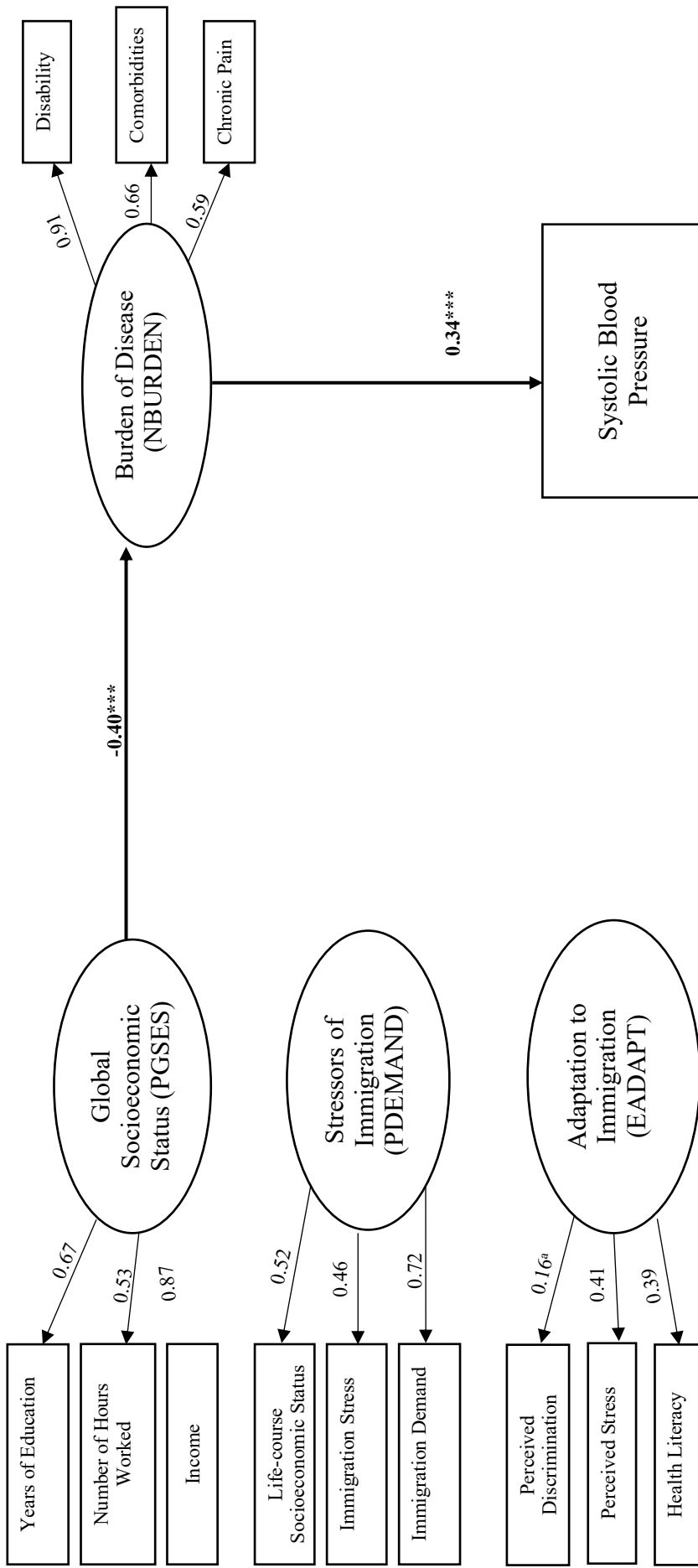
Figure 13. Full model with direct and indirect effects. Note: coefficients are standardized path coefficients. Overall model fit chi2 (69, n=181) = 149.98, p<0.001, RMSEA = 0.054, CFI = 0.94, TLI = 0.91, CD = 0.96. All factor loadings significant at p <0.001, except perceived discrimination, p=0.005. For paths *p<0.05; **p<0.01; ***p<0.001.

Table 6. Direct and Indirect Effects for Full Model

	Direct Effects	Indirect Effects	Total Effects
Systolic Blood Pressure			
→ Burden of Disease	0.34***	--	0.34***
→ Global Socioeconomic Status (SES)	0.11	-0.14**	-0.022
→ Stressors of Immigration	-0.17	-0.0019	-0.17
→ Adaptation to Immigration	0.031	0.060	0.91
→ Acculturation	-0.10	--	-0.10
Burden of Disease			
→ Global (SES)	-0.40**	--	-0.40**
→ Stressors of Immigration	-0.0055	--	-0.0055
→ Adaptation to Immigration	0.18	--	-0.18
Disability			
→ Burden of Disease	0.91***	--	--
→ Global SES	--	-0.36**	-0.36**
→ Stressors of Immigration	--	-0.01	-0.01
→ Adaptation to Immigration	--	0.16	0.16
Comorbidities			
→ Burden of Disease	0.66***	--	0.66***
→ Global SES	--	-0.26**	-0.26**
→ Stressors of Immigration	--	-0.004	-0.004
→ Adaptation to Immigration	--	0.12	0.12
Chronic Pain			
→ Burden of Disease	0.59***	--	0.59***
→ Global SES	--	-0.24**	-0.24**
→ Stressors of Immigration	--	-0.003	-0.003
→ Adaptation to Immigration	--	0.10	0.10

Manuscript 4: Contributions of Social Determinants of Health to Systolic Blood Pressure in United States Adult Immigrants: Use of Path Analysis to Validate a Conceptual Framework

Abstract

Objective: To validate a conceptual framework and identify pathways between antecedent (life-course socioeconomic status (SES)), predisposing (age, sex, married, homeless as a child alone), enabling (health literacy, acculturation), and need (disability) social determinants of health (SDoH) and systolic blood pressure (SBP) in US immigrant adults.

Methods: One hundred eighty-one immigrants were enrolled in the study. Path analysis was used to identify the paths by which SDoH influence SBP and to determine if antecedents, predisposing, enabling, and need factors have direct and indirect relationships with SBP.

Results: The final model (chi2 (5) = 14.88, p=0.011, RMSEA = 0.070, pclose = 0.17, CFI = 0.96) showed life-course socioeconomic status (SES) was directly associated with age (0.12, p=0.019) and disability (0.17, p=0.001); and indirectly associated with disability (0.29, p<0.001) and SBP (0.31, p<0.001). Age (0.31, p<0.001) and sex (0.25, p<0.001) were directly associated with SBP, and age was directly associated with disability (0.29, p<0.001) and indirectly associated with SBP (0.14, p=0.018). Other predisposing factors such as being married (-0.32, p<0.001) and being homeless as a child alone (0.16, p<0.001) were directly associated with disability and indirectly associated (0.14, p=0.018) with SBP. Enabling factor of health literacy (0.16, p=0.001) was directly

associated with disability and indirectly associated (0.14, p=0.018) with SBP. Need factor of disability (0.14, p=0.018) was directly associated with SBP.

Conclusions: This study provides the first validation of a conceptual model for the relationship between SDoH and SBP in adult immigrants and identifies potential targets for focused interventions.

Introduction

High blood pressure is one of the leading risk factors for the global burden of disease, accounting for more than 9 million deaths worldwide and 7% of global disability adjusted life years (DALYs) (Lim et al., 2012). It has been identified as a key risk factor for morbidity and mortality in the United States (US). For example, approximately 1000 deaths in the US each day are attributed to hypertension and more than 70% of individuals who have their first heart attack, stroke, and chronic heart failure have high blood pressure (Mozaffarian et al., 2015). In addition, hypertension imposes an enormous financial burden on the US with an estimated $112 billion in medical costs in 2015 which is expected to increase to $261 billion by 2035 (Khavjou et al., 2016).

Hypertension is of particular concern in foreign-born populations residing in the US, which totaled approximately 13% of the US population in 2018 (US Census Bureau, 2018). Research shows that newer immigrants, i.e. those who reside in the US for less than ten years, often have lower prevalence of hypertension compared to the US-born population; however, blood pressure increases as the length of residence increases, often surpassing levels of the native population (Brown et al., 2017; Commodore-Mensah et al., 2016; Commodore-Mensah et al., 2018; Gyamfi et al., 2017; Marshall et al., 2016; Salinas et al., 2014). While biological and genetic differences have been identified

between native-born and some immigrant groups, these differences have limited explanatory power for chronic diseases such as hypertension (Poston et al., 2001). Meanwhile, social determinants of health, or factors such as where one was born, lived, worked, or grew up, are known to influence health and often explain differences seen in health outcomes (WHO, 2017; CDC, 2017). Social determinants, such as culture and lifestyle, vary between US-born and immigrants due to country of birth or region of origin and may explain differences seen in the prevalence of hypertension (Poston et al., 2001; Bidulescu et al., 2015). Immigrants have different social determinants that influence health outcomes that differ from those commonly associated with native-born population, such as limited English proficiency, poverty, stress, low educational attainment, social isolation, lack of access to health care, inability to qualify for insurance due to legal status, and high disease burden (Zallman et al., 2013; Hall & Cuellar, 2016; Luque et al., 2018; Brown et al., 2017).

Previous research has established the relationship between antecedents, predisposing, enabling and need factors as predictors of health services use and clinical outcomes (Andersen, 1995; Coyle & Battles, 1999; Yang & Hwang, 2016). However, there is currently no validated conceptual model that explains the relationship between social determinants of health in the context of antecedents, predisposing, enabling, and need factors and blood pressure control, especially in immigrant populations. To address this gap in knowledge, we developed a theory-based conceptual framework by combining the concept of antecedents proposed by Coyle & Battles (Coyle & Battles, 1999) with the predisposing, enabling, and need factors proposed by Andersen (Andersen, 1995). We then incorporated immigrant-specific factors identified by Yang and Hwang (Yang & Hwang, 2016), as well as other factors noted in the literature to create a model that can be

tested to explain the relationship between social determinants and blood pressure control in immigrants (Figure 14).

In order to develop tailored interventions that target social determinants of health, it is important to understand the pathways by which social determinants influence blood pressure in immigrants. Therefore, we aimed to validate a new theory-based model and identify pathways between antecedent, predisposing, enabling, and need social determinants of health and systolic blood pressure in immigrant populations in the US. We hypothesized based on the model that antecedents, predisposing, enabling, and need factors will be directly and indirectly associated with systolic blood pressure.

Methods

Study Population

This was a cross-sectional study of 181 adult immigrants. The Medical College of Wisconsin Institutional Review Board approved the protocol and study procedures prior to initiating study recruitment and enrollment. The study team consisted of two bilingual English/Spanish individuals, and all members of the study team were trained in survey research. Immigrants, defined as anyone who was born outside of the United States and its territories were included in the study if they voluntarily agreed to participate, and were at least 21 years of age or older. Individuals were excluded if they exhibited signs of intoxication, dementia, or acute psychoses. Study participants were recruited using snowball, community-based, and clinic-based recruitment methods. Participants were asked to complete a questionnaire in English or Spanish that was made up of validated measures of social determinants of health. The study team read the questionnaire aloud in a private setting for individuals who had difficulty seeing, reading, or writing. The

validated measures were used to capture social determinants of health in terms of antecedents, predisposing, enabling, and need factors.

Conceptual Model

To account for our relatively small sample size, we used selected indicator variables from our newly developed theory-based conceptual model (shown in circles in Figure 14) to indicate measures of antecedents, predisposing, enabling, and need factors. These indicator variables were chosen because they had independent associations with SBP. Details of the variables and how they were measured are provided below.

Variables

Outcome: Systolic blood pressure was the main outcome and was measured at the time of the survey using the automated OMRON BP742N blood pressure monitor. Patients were seated for 5 minutes prior to obtaining the blood pressure reading based on guidelines for blood pressure measurement (AHA, 2018).

Antecedent:

Life-course Socioeconomic Status (Life-course SES): Life-course SES included the education level of the father, education level of the mother, size of family, birth order, and level of education (Wamala et al., 2001). Individuals who were born last, had more than three siblings, had less than a high school education, parents had less than a high school education, earned less than $25,000 per year, and were unemployed were each assigned one point, after which scores were summed for the individual to obtain a score of 0-7 with higher numbers indicating lower life-course SES.

Predisposing Factors:

Demographic Factors: Previously validated items from the National Health Behavioral Risk Factor Surveillance System (CDC BRFSS, 2014) were used to capture age (treated as continuous variable), sex, and marital status (married vs. not married). Homelessness: History of homelessness without a parent as a child was assessed using the segment Homeless History from the 1990 Course of Homelessness Study conducted by The Rand Corporation out of California (RAND, 2018).

Enabling Factors

Health Literacy: Health literacy was measured by the 3-item Chew literacy scale (Chew et al., 2008). The scale measures respondents' capacity to obtain, process, and understand basic health-related decisions (Chew et al., 2008). The three items were summed so that higher scores indicate lower health literacy.

Acculturation: The Marin and Marin Acculturation Scale assesses acculturation on three subscales (Language, Media, and Ethnic Social Relations) (Marin et al., 1987). Items are assessed using 5-point Likert scale and scores are summed to calculate acculturation score, with higher scores indicative of greater acculturation.

Need Factors

Disability: Disability was measured with the 8 previously validated items used by the Behavioral Risk Factor Surveillance System (CDC BRFSS, 2014) to capture health problems or impairments. Questions ask about limitations due to health, need for special equipment, and difficulty with tasks such as climbing stairs or going to the doctor office. The number of disabilities was summed to create a continuous measure.

Statistical Analysis

All analyses were conducted using STATA version 14. Descriptive statistics were calculated to describe the sample and to assess normality. The newly developed

conceptual model was used to build the path analysis model including antecedent (life-course SES), predisposing (age, sex, married, homeless as a child alone), enabling (health literacy, acculturation), and need factors (disability) as independent predictors of systolic blood pressure. Both direct and indirect pathways were hypothesized and therefore included in the model for each of these categories. Path analysis was used due to the ability to analyze complex models and because it is a multivariate analysis methodology that allows for the testing of multiple dependent and independent relationships simultaneously (Schumacker & Lomax, 2010). In path analysis, all potential hypothesized relationships are included based on a conceptual model, with significant relationships defined as path coefficients with p<0.05. In addition, the fit of the model overall is investigated and maximized to ensure the data supports the hypothesized overarching framework (Schumacker & Lomax, 2010; Kline, 2016). We used the maximum likelihood estimation procedure with standardized estimates, interpreted as the change in standard deviation of the outcome due to one standard deviation increase in the predictor. Standardized estimates are recommended due to the variability of the scales used to capture the measures of interest and are useful when comparing the impact of variables on the outcome (Kwan & Chan, 2011; Sanchez et al., 2005). The direct and indirect pathways were assessed by reviewing the direction and magnitude of path coefficients. Model fit was assessed using chi^2 statistic, root mean square error of approximation (RMSEA), and comparative fit index (CFI). Good model fit is indicated by non-insignificant chi^2 value and CFI 0.95 or greater (Kline, 2016; Hooper et al., 2008; Cangur & Ercan, 2015; Hu & Bentler, 1999). RMSEA of 0.05 – 0.07 indicates reasonable fit, and a value of 0.05 or less indicates good fit (Kline, 2016; Hooper et al., 2008; Cangur & Ercan, 2015; Hu & Bentler, 1999).

Results

Demographic characteristics of the sample of 181 adult immigrants in the US are shown in Table 1. Among the participants, mean years of school completed was 14.3, mean age was 45.4 years, the majority were female (66.3%), had a household income $\geq$ $25,000, and were insured (76.8%). About 39.8% were born in Asia, 33.7% in Central America/Mexico, 14.4% in Europe/Canada, and 12.1% in the Middle East/Africa.

Validation of the conceptual framework

The full final model (chi2 (5) = 14.88, p=0.011, RMSEA = 0.070, pclose = 0.17, CFI = 0.96) demonstrated good fit and is shown in Figure 15. All non-significant paths were removed for the trimmed model shown in Figure 16. The final model showed the antecedent (life-course socioeconomic status (SES)) was directly associated with predisposing factor of age (0.12, p=0.019) and need factor of disability (0.17, p=0.001); and indirectly associated with disability (0.29, p<0.001) and systolic blood pressure (SBP) (0.31, p<0.001). Predisposing factors of age (0.31, p<0.001) and sex (0.25, p<0.001) were directly associated with SBP, and age was directly associated with disability (0.29, p<0.001) and indirectly associated with SBP (0.14, p=0.018). The other predisposing factors being married (-0.32, p<0.001) and homeless as a child alone (0.16, p<0.001) were directly associated with disability and indirectly associated with SBP (0.14, p=0.018). Enabling factor of health literacy (0.16, p=0.001) was directly associated with disability and indirectly associated with SBP (0.14, p=0.018). Need factor of disability (0.14, p=0.018) was directly associated with SBP.

As indicated in Table 7, there were significant total effects of social determinants of health on SBP, including age (r=0.34, p<0.001), sex (r=0.25, p<0.001), and disability (r=0.14, p=0.02). There were also significant total effects between disability and social determinants, including life-course SES (r=0.21, p<0.001), age (r=0.30, p<0.001), being married (-0.32, p<0.001), being homeless as a child alone (r=0.16, p<0.001), and health literacy (r=0.16, p=0.001).

Discussion

We found predisposing (age, sex) and need (disability) factors to have a direct pathway to systolic blood pressure. In addition, we found antecedent (life-course SES), predisposing (age, married, homeless as a child alone), and enabling (health literacy), factors to have an indirect pathway to systolic blood pressure as hypothesized in the conceptual model. Contrary to our hypothesis, there was no significant pathway from predisposing to enabling factors (such as acculturation). The identified direct and indirect relationships suggest that lower SES is associated with increased disability; and increasing age is associated with increased disability and increased SBP. Male sex was found to be directly associated with increased SBP, while being married was found to be associated with decreased disability and indirectly with decreased SBP. Being homeless as a child alone was directly associated with increased disability and indirectly associated with increased SBP, and having low health literacy was found to be directly associated with increased disability and indirectly associated with increased SBP.

This is the first study to our knowledge to test and validate a theory-based conceptual framework that explains the relationship between social determinants of health categorized as antecedents, predisposing, enabling, need, and blood pressure in an

adult immigrant sample. The model was created based on identification of existing health services research models and the addition of immigrant specific factors allowing for the conceptualization and analysis of the relationships between immigrant-specific social determinants of health and outcomes. We were also able to successfully elucidate both direct and indirect pathways, providing additional explanatory power of these relationships. By understanding the mechanism by which social determinants of health affects SBP we are able to identify potential pathways that can be targets for interventions to control blood pressure in immigrant populations. Based on these findings, history of low life-course SES, homelessness as a child without a parent or guardian, low health literacy, and high disability burden in immigrant adults should be red flags for clinicians and other healthcare providers and should trigger aggressive psychosocial and clinical interventions to lower blood pressure.

While factors such as acculturation are often highlighted as key predictors of immigrant health (Teppala et al., 2010; Moran et al., 2007; Steffen et al., 2006), we did not find significant pathways between acculturation and either disability or systolic blood pressure. This finding highlights the strength of using robust methodologies such as SEM and path analysis that account for error terms, and allow for the inclusion of multiple dependent and independent variables in one model. The inclusion of multiple dependent and independent variables in one model allows for accounting of overlapping influence and studying of both direct and indirect effects. By testing direct and indirect pathways we are able to find unique contribution of variables to target interventions. Interventions can be developed to target direct or indirect predictors of the outcome, increasing the number of ways diseases can be improved. For example, interventions to increase life-course SES through education, job and skills training to increase one's earning potential;

health literacy interventions; or programs to decrease or manage disabilities are all viable courses of action for improving hypertension in immigrants based on our findings. Our results illustrate the need for additional work on understanding the pathways by which social determinants of health influence hypertension and other CVD risk factors, particularly obesity, high cholesterol, and diabetes. Future research should include larger and more diverse samples of immigrant groups residing in different regions of the US to contribute to the body of knowledge and increase generalizability.

Our study has two main strengths: 1) utilization of path analysis, a robust methodology that allows us to understand the pathways by which social determinants of health influence blood pressure, and 2) inclusion of a diverse sample of immigrants from multiple regions of the world. The study also has two limitations that should be acknowledged. First, the study was conducted with a relatively small sample of immigrants residing in the Midwestern United States and should be conducted with immigrants residing in other US regions. Second, due to the cross-sectional study design, causality cannot be inferred based on the results.

Conclusions

To conclude, this study validated a theory-based conceptual model of the relationship between social determinants of health categorized as antecedents, predisposing, enabling, and need factors and blood pressure. Predisposing and need factors, specifically age, sex and disability, had a direct path to SBP, and antecedents, predisposing, and enabling factors, specifically life-course SES, married, homeless as a child alone, and health literacy had an indirect path to SBP. Based on these findings, history of low life-course SES, homelessness as a child without a parent or guardian, low

health literacy, and high disability burden in immigrant adults should be red flags for clinicians and other healthcare providers and should trigger aggressive psychosocial and clinical interventions to lower blood pressure.
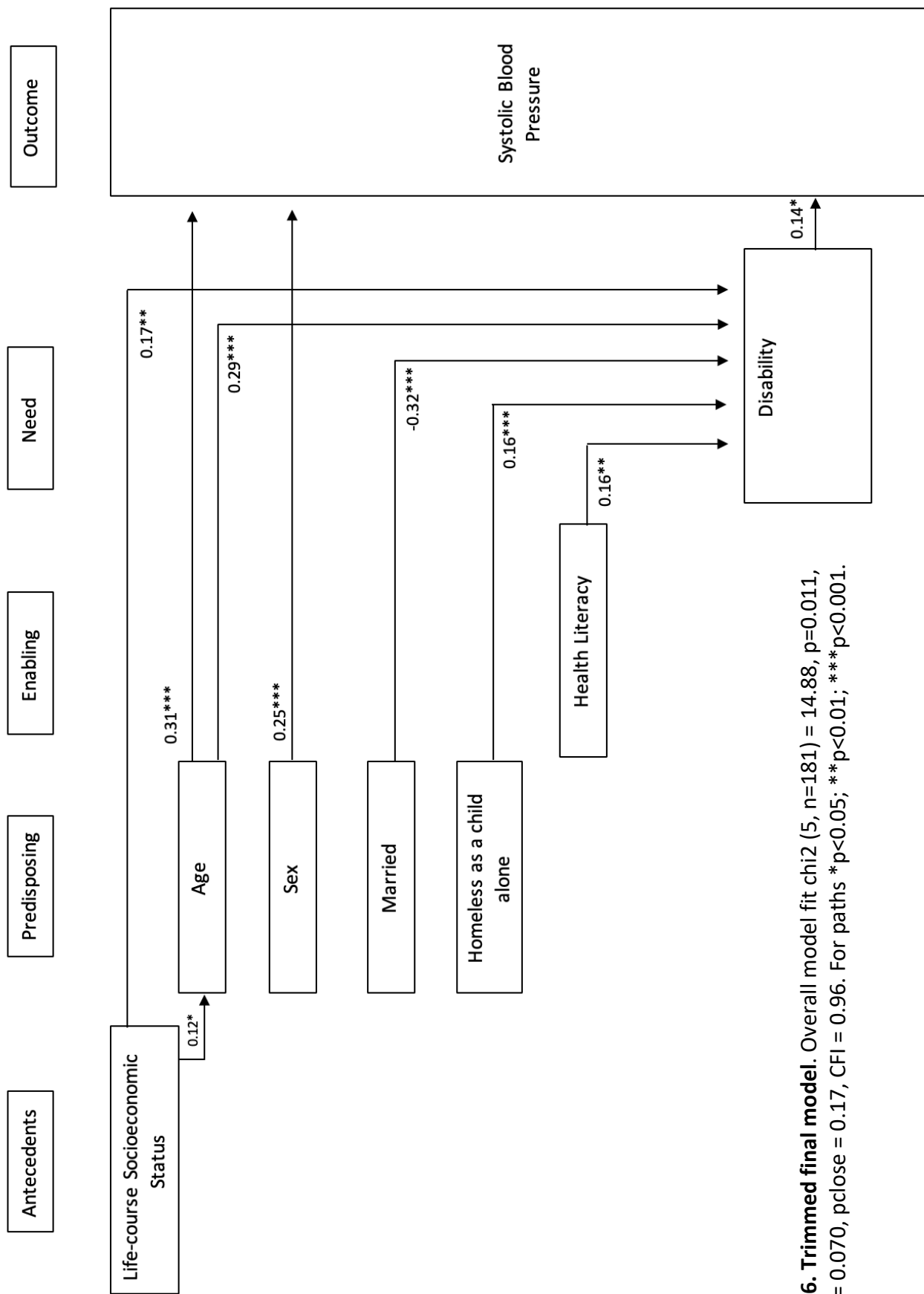
Figure 14. Theory-based conceptual model for immigrant social determinants of health outcomes (with indicator variables in circles)

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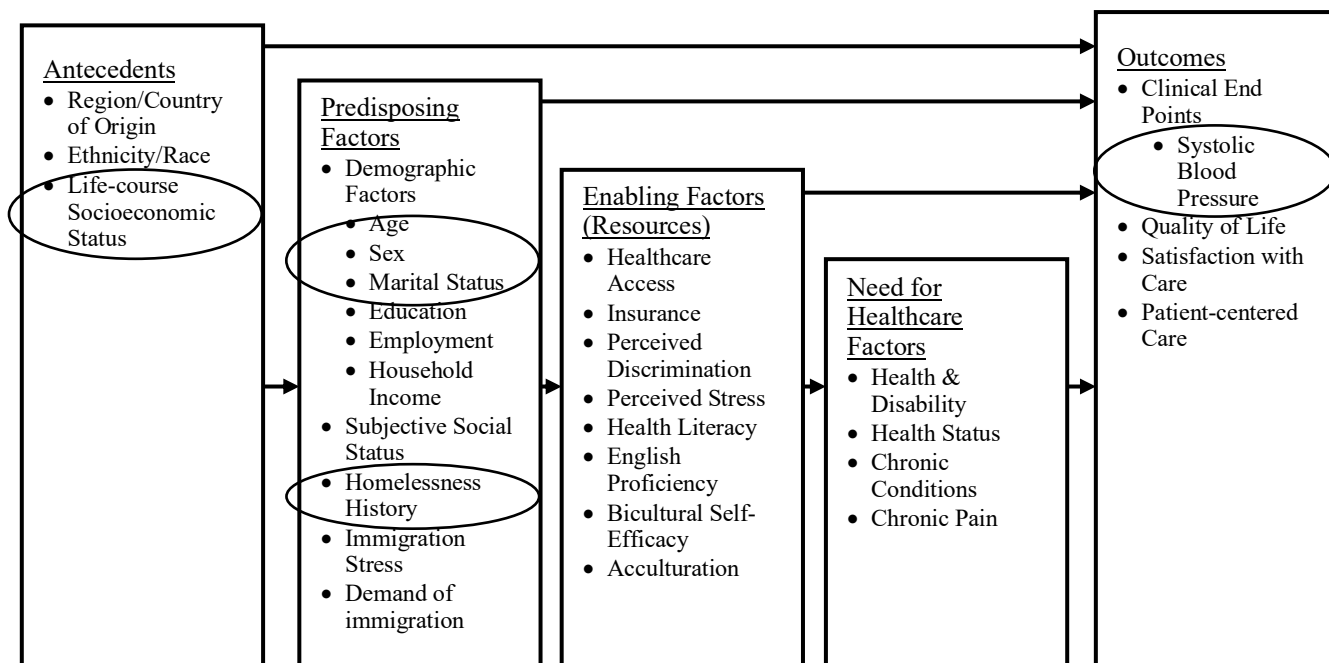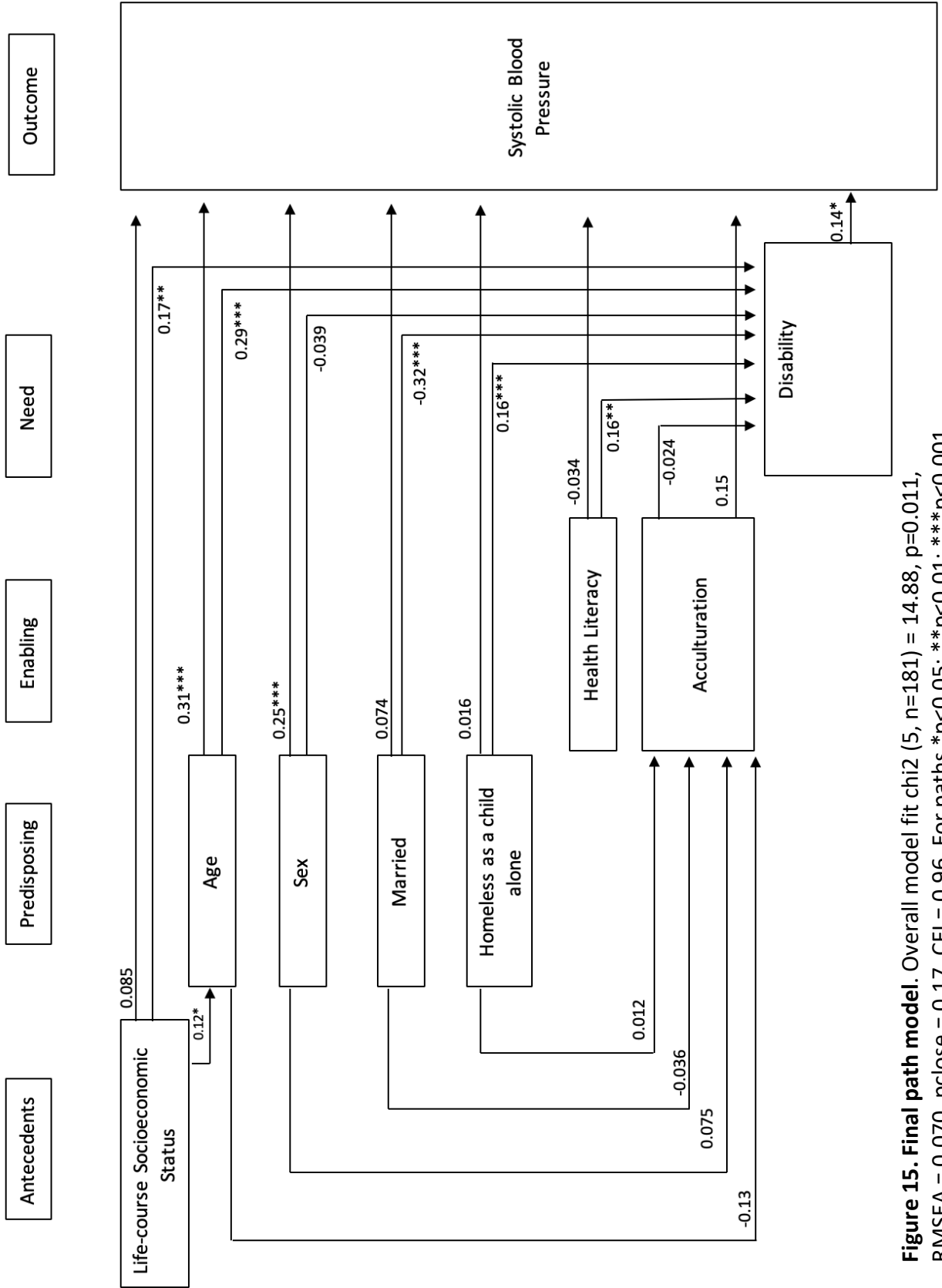
Figure 15. Final path model. Overall model fit chi2 (5, n=181) = 14.88, p=0.011, RMSEA = 0.070, pclose = 0.17, CFI = 0.96. For paths *p<0.05; **p<0.01; ***p<0.001.

Figure 16. Trimmed final model. Overall model fit chi2 (5, n=181) = 14.88, p=0.011, RMSEA = 0.070, pclose = 0.17, CFI = 0.96. For paths *p<0.05; **p<0.01; ***p<0.001.

Table 7. Direct, Indirect and Total Effects of Antecedent, Predisposing, Enabling and Need Variables on Systolic Blood Pressure

	Direct Effects	Indirect Effects	Total Effects
Systolic Blood Pressure			
Antecedent			
→ Life-course Socioeconomic Status (SES)	0.085	0.017	0.10[a]
Predisposing			
→ Age	0.31***	0.022	0.34***
→ Sex	0.25***	0.0053	0.25***
→ Married	0.074	-0.49*	0.024
→ Homeless as a Child Alone	0.16	0.024	0.040
Enabling			
→ Health Literacy	-0.34	0.021[a]	-0.12
→ Acculturation	0.15	-0.0033	0.14
Need			
→ Disability	0.14*	--	0.14*
Disability			
Antecedent			
→ Life-course Socioeconomic Status (SES)	0.17**	0.043	0.21***
Predisposing			
→ Age	0.29***	0.0031	0.30***
→ Sex	-0.039	-0.0018	-0.041
→ Married	-0.32***	0.00085	-0.32***
→ Homeless as a Child Alone	0.16***	-0.00028	0.16***
Enabling			
→ Health Literacy	0.16**	--	0.16**
→ Acculturation	-0.024	--	-0.024
Acculturation			

Antecedent			
→ Life-course Socioeconomic Status (SES)	-0.32***	-0.015	-0.34***
Predisposing			
→ Age	-0.13	--	-0.13
→ Sex	0.075	--	0.075
→ Marital Status	-0.036	--	-0.036
→ Homeless as a Child Alone	0.012	--	0.012
Age			
Antecedent			
→ Life-course Socioeconomic Status (SES)	0.12*	--	0.12*

a p=0.05, *p<0.05, **p<0.01, ***p<0.001

Conclusions

In conclusion, this dissertation examined the relationship between social determinants of health and blood pressure in adult immigrants residing in the Midwestern United States. First a conceptual framework was developed incorporating general and immigrant specific social determinant of health factors, which were categorized into antecedents, predisposing, enabling, and need factors. Secondly, 181 immigrants were recruited from clinics, community centers, churches, and other community-based sites, who completed self-administered questionnaires to collect responses on constructs determined by the conceptual framework as relevant. Finally, a series of analyses were run to investigate the relationship and pathways linking social determinants of health to hypertension. Regression methods including sequential modeling, stepwise regression with backward selection, and all possible subsets regression were used, along with confirmatory factor analysis to incorporate latent structures, structural equation modeling, and path analysis to identify direct effects, indirect effects.

Aim 1 showed that using measured social determinant variables, antecedents (life-course SES) and predisposing (age, sex, homeless as a child alone) factors are significantly associated with systolic blood pressure. Aim 2 showed that it is possible to create latent variables for social determinants of health and that they have a significant impact on systolic blood pressure. It was found that two predisposing (global SES and stressors of immigration), two enabling (adaptation to immigration and acculturation), and one need (burden of disease) latent factor existed. Aim 3 showed that predisposing factors (global SES) have a direct effect on need (burden of disease) and an indirect effect on systolic blood pressure; and need (burden of disease) factors have a direct effect on systolic blood pressure. Finally, aim 4 was the first study to validate a conceptual

framework for the relationship between immigrant specific social determinants of health identified as antecedents, predisposing, enabling, and need factors and systolic blood pressure, facilitating the identification of targets for future intervention development and social determinant factors that should be considered by healthcare providers as an indicator of possible need for additional support to manage hypertension.

Based on these findings, history of low life-course SES, homelessness as a child without a parent or guardian, low health literacy, and high disability burden in immigrant adults should be red flags for clinicians and other healthcare providers and should trigger aggressive psychosocial and clinical interventions to lower blood pressure. Consistent with the validated Dawson and Egede model, social determinants of health were directly and indirectly associated with blood pressure. Future interventions should target each category of social determinants that were included in the model such as predisposing (ie homelessness), enabling (ie health literacy), and need (ie disability) factors using multi-component programs to be effective at improving outcomes in hypertensive adult immigrant populations.

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