

## Research Paper

## Relationship between social determinants of health and systolic blood pressure in United States immigrants

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**Condensed abstract:** The aim of this study was to examine the relationship between social determinants of health (SDoH) and blood pressure control in immigrants in the Midwestern United States. This study was conducted with 181 immigrants and found life-course SES, age, male sex, and being homeless as a child without a parent/guardian to be associated with systolic blood pressure. 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 in immigrants.

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## ABSTRACT

This study examined the relationship between immigrant specific social determinants of health (SDoH) and blood pressure control.

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.

About 66% were female and mean age was 45.4 years. 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) ( $\beta = 1.40$ ,  $p = 0.039$ ), age ( $\beta = 0.39$ ,  $p < 0.001$ ), and male sex ( $\beta = 13.62$ ,  $p < 0.001$ ) to be positively associated with SBP. Stepwise regression found that life-course SES ( $\beta = 1.70$ ,  $p = 0.026$ ), age ( $\beta = 0.36$ ,  $p < 0.001$ ), male sex ( $\beta = 13.38$ ,  $p < 0.001$ ), and homelessness as a child ( $\beta = 13.14$ ,  $p = 0.034$ ) were positively associated SBP. All possible subsets regression found that age ( $\beta = 0.44$ ,  $p < 0.001$ ), male sex ( $\beta = 14.50$ ,  $p < 0.001$ ), and homelessness as a child ( $\beta = 14.08$ ,  $p = 0.027$ ) were positively associated with SBP.

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.

## 1. 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 [1]. The global prevalence of hypertension was about 40% in 2008 [2], and is estimated to cause 7.5 million deaths worldwide, accounting for approximately 57 million disability adjusted life years

(DALYs) [1,2]. While high blood pressure is a prevalent condition, differences in prevalence between native born and foreign-born populations have been noted [3–6].

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 [7]. Studies have demonstrated differences in morbidity and mortality from hypertension between immigrants and US

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born adults and these differences have been attributed to genetic, biological and lifestyle factors [3,8–12]. 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 [13,14]. 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 [15].

Immigrants have differences in lifestyle and diet that may affect their risk for developing chronic diseases such as hypertension [16–19]. 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 [3]. These findings support the idea that immigrants have more favorable health behaviors that are associated with lower risk of chronic disease [3]. It is well known that more-recent immigrants have lower blood pressure than those living in the US for longer periods of time [3–6,20]. This phenomenon is true not only for the US, but for other countries around the world [6,9]. 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 [6]. 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 [21]. 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 [21].

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.

## 2. Methods

### 2.1. Study population

This was a cross-sectional study of 181 immigrants in 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. Study inclusion criteria included: 1) being an immigrant, defined as an individual who reported being born outside of the United States and its territories; 2) aged 21 and older. The exclusion criteria included: showing signs of acute psychosis, dementia,

or intoxication. We used a variety of complementary methods to identify eligible study participants within the immigrant community including phone calls, mailings, media, clinic-based recruitment, community-based recruitment and snowball recruitment. There was an average response rate of 90%. 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.

### 2.2. 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 [22,23]. Immigrant specific factors noted in the Yang & Hwang model of 2016 were additionally added to the conceptual model [24]. The final model, showing in Fig. 1, 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.

### 2.3. Variables

#### 2.3.1. Outcome

Systolic blood pressure was the main outcome and was measured at the time of the survey using the automated OMRON BP742 N blood pressure monitor. Blood pressure measurements were collected at the site of survey administration (academic medical center, community centers, churches, barber shops, food pantries, and public libraries). Patients were seated for 5 min prior to obtaining the blood pressure reading based on guidelines for blood pressure measurement [25]. The study team was trained by clinicians on the procedures to follow for conducting attended blood pressure measurements using an automated device. Blood pressure cuffs were adapted to appropriately fit each participant's arm circumference and one reading was recorded.

### 2.4. Antecedents

#### 2.4.1. Region/country of origin

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.

#### 2.4.2. Ethnicity/race

Previously validated items from the National Health Behavioral Risk Factor Surveillance System [26] were used to capture Hispanic ethnicity and four categories of race (Black/African American, White, Asian, Other).

#### 2.4.3. 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 [27]. 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

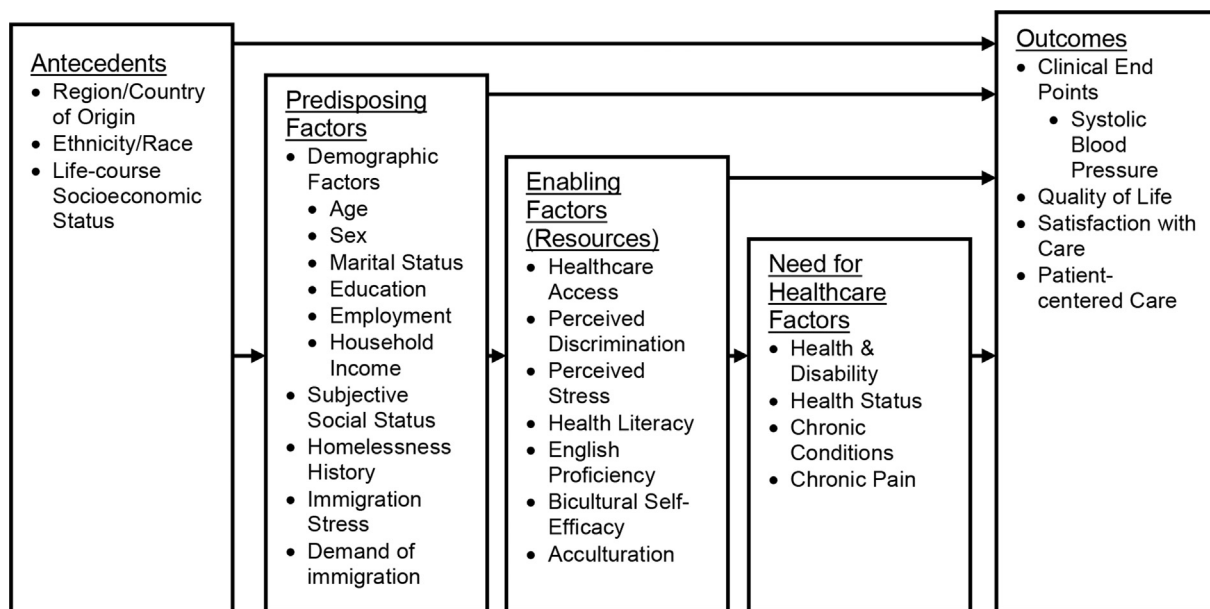


Fig. 1. Dawson and Egede conceptual model for relationship between social determinants of health and health outcomes among immigrants.

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.

#### 2.4.4. Predisposing factors

**2.4.4.1. Demographic factors.** Previously validated items from the National Health Behavioral Risk Factor Surveillance System [26] 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.

#### 2.4.5. Subjective social status (SSS)

SSS is a perceived measure of socioeconomic status that independently predicts health outcomes [28]. 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 [28].

#### 2.4.6. 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 [29]. 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).

#### 2.4.7. 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 [30]. Respondents were asked the degree to which they found various circumstances stressful as it relates to migration [30]. The BCIS 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.

#### 2.4.8. Demand of immigration (DI)

The DI scale is a validated scale that measures distress related to migration and leaving friends and family behind [31]. 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.

#### 2.5. Enabling factors

##### 2.5.1. Health care access

Previously validated items from the 2010 Medical Expenditure Panel Survey – Household Component [32] and Behavioral Risk Factor Surveillance System [26] were used to capture having a usual source of care, visiting a primary care provider within the past year and having health insurance.

##### 2.5.2. Perceived discrimination

Previously validated items from the DISTANCE survey [33] 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.

##### 2.5.3. Perceived stress

The perceived stress scale (PSS) is a 4-item scale that assesses the degree to which the respondent finds situations stressful [34]. Responses range from “0” (never) to “4” (very often) and questions ask about the frequency of feelings related to events in the previous month [34]. The Cronbach alpha value is 0.69 and high scores are highly correlated with stress, depression and anxiety [35].

##### 2.5.4. Health literacy

Health literacy was measured by the 3-item Chew literacy scale [36]. The scale measures respondents’ capacity to obtain, process, and understand basic health-related decisions [36]. The three items were summed so that higher scores indicate lower health literacy.

### 2.5.5. 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 [37]. Higher scores indicate higher English language proficiency.

### 2.5.6. Bicultural self-efficacy

Bicultural Self-Efficacy was assessed using a 26-item scale [38]. 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.

### 2.5.7. Acculturation

The Marin and Marin Acculturation Scale assesses acculturation on three subscales (Language, Media, and Ethnic Social Relations) [37]. Items are assessed using 5-point Likert scale and scores are summed to calculate acculturation score, with higher scores indicative of greater acculturation.

## 2.6. Need factors

### 2.6.1. Disability

Disability was measured with the 8 previously validated items used by the Behavioral Risk Factor Surveillance System [26] 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.

### 2.6.2. Chronic conditions

Previously validated items from the Behavioral Risk Factor Surveillance System [26] were used to capture the existence of medically comorbid conditions. A continuous variable was created as a count the number of comorbidities reported.

### 2.6.3. Chronic pain

Previously validated items from the Diabetes Study of Northern California (DISTANCE) survey [33] 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.

## 2.7. 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  $\leq 0.2$ . 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  $\leq 0.2$  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 [39]. For the third approach, we used all possible subsets or best subsets regression [40]. 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 [40]. 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.

## 3. 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. About 29.8% had hypertension, 15.5% had diabetes, and 30.9% had high cholesterol. Additionally, 62.9% were overweight/obese according to body mass index, and 3.9% were current smokers.

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. While age, disability and comorbidities remained independently associated with systolic blood pressure, chronic pain and number of hours worked per week were no longer independently significant and therefore were not included in the unadjusted or final models.

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 ( $\beta = 1.40$ ,  $p = 0.039$ ), age ( $\beta = 0.39$ ,  $p < 0.001$ ), and male sex ( $\beta = 13.62$ ,  $p < 0.001$ ) to be positively associated with systolic blood pressure. Homelessness without a parent as a child trended towards significance ( $\beta = 12.34$ ,  $p = 0.051$ ). Using the second approach (stepwise regression with backward elimination), it was found that life-course SES ( $\beta = 1.70$ ,  $p = 0.026$ ), age ( $\beta = 0.36$ ,  $p < 0.001$ ), male sex ( $\beta = 13.38$ ,  $p < 0.001$ ), and homelessness without a parent as a child ( $\beta = 13.14$ ,  $p = 0.034$ ) were positively associated with systolic blood pressure. The final approach (all possible subsets regression) found that age ( $\beta = 0.44$ ,  $p < 0.001$ ), male sex ( $\beta = 14.50$ ,  $p < 0.001$ ), and homelessness without a parent as a child ( $\beta = 14.08$ ,  $p = 0.027$ ) were positively associated with systolic blood pressure.

## 4. 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



**Table 1**  
Sample characteristics.

n = 181	Percent or Mean (Standard Deviation)
<b>Age</b>	
Mean Age	45.4 (16.6)
18–64	81.8%
65–94	18.2%
<b>Sex</b>	
Female	66.3%
Male	33.7%
<b>Years of School</b>	
Mean Years of School	14.3 (5.5)
≤ High School Graduate	32.8%
College/Graduate Education	67.2%
<b>Employed</b>	
Mean # of Hours Worked	24.9 (20.2)
No	42.5%
Yes	57.5%
<b>Ethnicity - Hispanic or Latino</b>	
No	68%
Yes	32%
<b>Race</b>	
White	32.6%
Black	11.6%
Asian	35.9%
Other	21.6%
<b>Region of Birth</b>	
Europe/Canada	14.4%
Central America/Mexico	33.7%
Asia	39.8%
Middle East/Africa	12.1%
<b>Years of Residence in the United States</b>	
Mean	21.6 (16.2)
Median	19
<b>Household Income</b>	
≥ \$25,000	57.5%
< \$25,000	42.5%
<b>Insured</b>	
No	23.2%
Yes	76.8%
<b>Mean Blood Pressure</b>	
Systolic	122 (17.0)
Diastolic	78.2 (9.6)
<b>Body Mass Index</b>	
Underweight/Normal	37.1%
Overweight/Obese	62.9%
<b>Smoking</b>	
Current	3.9%
Former	14.6%
Never	81.5%
<b>Hypertension</b>	
No	70.2%
Yes	29.8%
<b>Diabetes</b>	
No	84.5%
Yes	15.5%
<b>Myocardial Infarction</b>	
No	95.6%
Yes	4.4%
<b>Angina</b>	
No	97.8%
Yes	2.2%
<b>High Cholesterol</b>	
No	69.1%
Yes	30.9%
<b>Stroke</b>	
No	95.0%
Yes	5.0%

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 [41]. 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 [42]. 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 [42,43]. 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 [44]. 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 [45,46]. 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 [47]. 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 [48–50]. 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 [49,50]. 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 small 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 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 <sup>a</sup>	–																	
Antecedent																		
2. Lifecourse SES <sup>b</sup>	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 <sup>c</sup>	–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 <sup>d</sup>	–0.074	0.10	–0.25***	–0.042	0.076	–0.13**	–0.16**	0.33***	0.27***	–								
11. PS <sup>e</sup>	–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 <sup>f</sup>	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 <sup>g</sup>	–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.

<sup>a</sup> Systolic blood pressure.

<sup>b</sup> Lifecourse socioeconomic status.

<sup>c</sup> Subjective social status.

<sup>d</sup> Perceived discrimination.

<sup>e</sup> Perceived stress.

<sup>f</sup> English proficiency.

<sup>g</sup> Bicultural self-efficacy.

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

	Approach 1	Approach 2	Approach 3
Adjusted R <sup>2</sup>	0.35	0.37	0.40
<b>Antecedents</b>			
Lifecourse SES	1.40*	1.70*	1.23
<b>Predisposing Factors</b>			
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 <sup>a</sup>	13.14*	14.08*
Demand of immigration			-0.13
<b>Enabling Factors</b>			
Healthcare Access	1.79		
Perceived Discrimination			1.28
Health Literacy		-2.42	
Bicultural Self-Efficacy	-0.82		
Acculturation	2.28	1.86	
<b>Need Factors</b>			
Disability		1.40	
Comorbidities	0.090		

<sup>a</sup> 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.

### Authors' contributions

LEE obtained funding for the study. AZD, RJW, CG and LEE designed the study. LEE, RJW, and AZD acquired and analyzed the data. AZD drafted the article. RJW, AZD, CG, and LEE critically revised the manuscript for intellectual content. All authors approved the final manuscript.

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### Conflict of interest

All authors declare they have no conflict of interest.

### Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

### Data availability

Data used for this study is available upon request from LEE.

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