# Association Between Length of Residence and Cardiovascular Disease Risk Factors Among an Ethnically Diverse Group of United States Immigrants

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**BACKGROUND:** Although differences in cardiovascular disease (CVD) risk factors between immigrants and nonimmigrants have been examined previously, the effect of acculturation on CVD risk factors in immigrants has been less well studied.

**OBJECTIVE:** To determine the association between length of U.S. residence (proxy for acculturation) and major CVD risk factors.

**METHODS:** Data on 5,230 immigrant adults from the 2002 National Health Interview Survey (NHIS) was analyzed. Primary independent variable was length of U.S. residence <10, 10 to <15, and ≥15 years. Main outcome measures included obesity, hypertension, diabetes, hyperlipidemia, smoking, and physical inactivity. Multiple logistic regression was used to assess the association between length of residence and odds of multiple CVD risk factors adjusting for confounders. SAS-callable SUDAAN was used for statistical analysis.

**RESULTS:** Among the patients, 55.4% were obese, 17.3% had hypertension, 15.9% had hyperlipidemia, 6.6% had diabetes, 79.3% were physically inactive, and 14.3% were smokers. Using <10 years as reference, those with length of residence ≥15 years were more likely to be obese (OR 1.31, 95% CI 1.03–1.65), have hyperlipidemia (OR 1.59, 95% CI 1.14–2.22), and be smokers (OR 1.39, 95% CI 1.04–1.85). Length of residence ≥15 years was associated with decreased odds of sedentary lifestyle (OR 0.63, 95% CI 0.47–0.84). Length of residence ≥15 years was not associated with odds of having diabetes (OR 1.40, 95% CI 0.78–2.51) or hypertension (OR 1.21, 95% CI 0.86–1.71).

**CONCLUSIONS:** Among immigrants from diverse ethnic backgrounds, longer length of residence in the United States is associated with increased odds of obesity, hyperlipidemia, and cigarette smoking even after adjusting for relevant confounding factors.

KEY WORDS: length of residence; cardiovascular disease; immigrants; race/ethnicity.

## INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of mortality and morbidity in the United States accounting for more than 40% of all deaths[1]. Aggressive clinical and public health interventions have resulted in significant reduction in CVD mortality and CVD risk factors. However, there is troubling evidence that the prevalence of CVD risk factors like physical inactivity, obesity, diabetes, and hypertension is on the rise[1]. Although immigrants represent a large and growing segment of the U.S. population, there is little data on the epidemiology of CVD risk factors among US immigrants. Because CVD risk factors are substantially influenced by behavioral, social, cultural, and economic factors[2–5], it is important to know how CVD risk factors differ between immigrant and nonimmigrant populations of the United States.

Immigrants tend to have better health and lower mortality rates despite disparities in health and access to care[6–11]. This is specifically true for Hispanic immigrants and is referred to as the 'Hispanic paradox'[12]. There are 2 hypotheses for these findings. The first hypothesis, positive immigrant selectivity, hypothesizes that migration is selective of healthier and more robust persons, a phenomenon called "healthy migrant" effect[13–15]. The second hypothesis suggests that immigrants are more likely to be characterized by norms and values that proscribe risky behaviors like smoking, alcohol use, and promote healthy behaviors including stronger familial support and better nutrition[16–19]. With increasing length of residence in the United States, immigrants are more likely to get acculturated to U.S. norms resulting in a threat to these proposed health advantages and, hence, a decline in their health status which is referred to as "acculturation hypothesis".

Prior studies have documented an association between increasing length of residence in the United States and increased odds of obesity, smoking, and certain chronic health conditions[6,8,20–22]. However, these studies have only focused on single behaviors or disease conditions and most have been conducted in Hispanics. No prior study has comprehensively examined the association between increasing length of residence in the United States and multiple CVD risk factors and/or across diverse ethnic group of U.S. immigrants. The objective of this study was to determine the association

between length of residence (a proxy measure for acculturation) and odds of multiple CVD risk factors including obesity, hypertension, hyperlipidemia, diabetes mellitus, physical inactivity, and cigarette smoking among an ethnically diverse group of U.S. immigrants. We used a nationally representative survey—the 2002 National Health Interview Survey (NHIS)—to test the hypothesis that among an ethnically diverse group of immigrants, increasing length of stay in the United States would be associated with increased odds of having multiple CVD risk factors even after controlling for relevant confounding factors.

# METHODS

***Data Source.*** Data on adults from the 2002 NHIS were analyzed. The NHIS is an annual household interview of the civilian noninstitutionalized population of the United States conducted by the National Center for Health Statistics[23]. The 2002 NHIS survey was administered in English and Spanish, and family members were allowed to translate for non-English or non-Spanish speaking respondents present in the home. NHIS data are obtained through a complex, multistage sampling design that involves stratification, clustering, and oversampling of specific population subgroups, with a nonzero probability of selection for each person. The sample is weighted to account for the complex sampling design and for nonresponse.

***Definition of Immigrant.*** Foreign birth was considered as a proxy for immigrant status and, hence, the terms "immigrant" and "foreign-born" are used interchangeably in the text. Based on the responses to the question "Where were you born?", we defined foreign-birth as birth place either in a U.S. territory or outside of the United States. All naturalized citizens, legal permanent residents, undocumented immigrants, and nonimmigrants (students, guest workers) fall in foreign-born category. U.S. or native-born refers to individuals born in the 50 contiguous states and the District of Columbia.

***Demographic and Socioeconomic Variables.*** Four age categories were created: 18–34, 35–49, 50–64, and ≥65 years. Marital status was categorized as married or living with partner, never married, and previously married (divorced, widowed, and separated). Race/ethnicity was defined as Hispanic, non-Hispanic White, non-Hispanic Black, and non-Hispanic "Other". Education was categorized as: <high school graduate, high school graduate, <4 years of college, and ≥college graduate. Annual household income was dichotomized as <$20,000 and ≥$20,000. Employment status was recoded as currently working, retired, and former/never worked.

***Access to Health Care and Health Status.*** Health insurance was defined as government insurance, private insurance, and no insurance. Source of care was defined as having a source of health care when sick (yes or no). Self-assessed health was categorized as excellent/very good, good, and fair/poor.

***Length of U.S. Residence.*** Foreign-born respondents were categorized by NHIS according to their years of residence in the United States (<1, <5, <10, <15, or ≥15 years) based on their response to the question "About how long have you been in the United States?" Due to sample size constraints, we collapsed these categories into 3 categories (<10, 10 to <15, and ≥15 years) for our analyses. We made this categorization for ease of interpretation and because previous studies have shown that CVD risk factors increase significantly after living in the United States for at least 10 years, suggesting a threshold effect[20].

***Geographic Region of Birth for Foreign Born.*** Eleven categories of region of birth were provided by NHIS: Mexico, Central America, Caribbean Islands, South America, Europe, Russia, Africa, the Middle East, India, Asia, South East Asia, and elsewhere. Due to sample size constraints, we collapsed these categories into 4 categories: (1) South/Central America (Mexico, Central America, Caribbean Islands, and South America); (2) Europe (Europe and Russia); (3) Africa; and (4) Middle East/Asia (Middle East, India, Asia, South East Asia, and elsewhere).

***Citizenship Status.*** This was assessed based on response to the question "Are you a citizen of the United States?" Among foreign-born persons, those who were born in the U.S. territories or who became U.S. citizens by naturalization were considered U.S. citizens.

***CVD Risk Factors.*** The 6 CVD risk factors studied were obesity/overweight, hypertension, hyperlipidemia, diabetes mellitus, physical inactivity, and current cigarette smoking.

***Obesity/Overweight.*** We defined obesity/overweight as body mass index (BMI) ≥25. NHIS calculates BMI from self-reported information on height and weight. BMI was coded as a dichotomous variable (obesity/overweight vs normal weight).

***Diabetes, Hypertension, and Hyperlipidemia.*** Data on diabetes, hypertension, and hyperlipidemia were all based on self-reported information about whether the respondent had ever been told by a doctor or health professional that he or she had that condition (yes or no). These were coded as dichotomous variables (yes vs no) based on presence or absence of the relevant disease condition.

***Current Smoking.*** Smoking status was categorized as current smoker, former smoker, or never smoked. A current smoker was defined as someone who smoked at least 100 cigarettes in their lifetime and was currently smoking. For multivariate analysis, we dichotomized smoking status as current smoker vs former smoker/never smoked.

***Physical Inactivity.*** Respondents were asked: (1) "How often do you do light or moderate activities for at least 10 minutes that cause only light sweating or a slight to moderate increase in breathing or heart rate? (2) "How often do you do vigorous activities for at least 10 minutes that cause heavy sweating or

large increases in breathing or heart rate?" Physical activity level was categorized as sedentary/physical inactive (no moderate or vigorous physical activity/week or moderate or vigorous activity <1 time/week), moderate physical activity (vigorous activity, 1 time/week or moderate activity, 1–3 times/week), and vigorous physical activity (vigorous activity ≥2 times/week or moderate activity ≥4 times/week). This categorization has been used in previous studies and has been previously validated[20,24]. For multivariate analysis, we dichotomized this variable as physically inactive versus physically active (vigorous or moderate activity).

## Statistical Analysis

Analyses were conducted to determine differences in demographic and socioeconomic characteristics, and prevalence of each CVD risk factor by length of residence in the United States using chi-square tests. Differences in CVD risk factors by region of birth were also assessed using chi-square tests. Age- and sex-adjusted prevalence of CVD risk factors by length of U.S. residence were assessed, and test for trend was conducted to assess the linear trend in CVD risk factor prevalence across the 3 categories of length of residence. A 2-tailed alpha with $P<.05$ was considered statistically significant for all analyses.

To account for confounding, 6 different multiple logistic regression models were fitted using each CVD risk factor as an outcome variable and length of U.S. residence as the primary independent variable (reference group, <10 years) controlling for age, gender, marital status, region of birth, race/ethnicity, education, income, employment, insurance, source of usual/sick care, citizenship status, and self-reported health status. In addition to these covariates, physical activity was also included as a confounder in the model where obesity was used as an outcome variable. Covariates were selected based on their clinical relevance, results from our bivariate analysis, and findings from previous studies showing that these variables confound the association between length of residence and CVD risk factors[8,20–22]. Because region of birth was significantly associated with CVD risk factors and length of residence, we treated it as a confounder and included it as a covariate in the multivariate models. For each CVD risk factor, we ran separate models for men and women because previous studies have shown variation in the associations between health behaviors and acculturation by gender. In all analyses when data were unknown/missing for key data elements, the observations with missing data were excluded. For all analyses, data were weighted to reflect national population estimates with SAS-callable SUDAAN software, version 9.0.1 (Research Triangle Institute, Research Triangle Park, NC) to account for the complex survey design of the NHIS.

## RESULTS

**Sample Characteristics.** Approximately 31,044 adults completed the survey with a final survey response of 74.3%. Of this number, 5,230 adults were immigrants, which represent 14.5% of the population. Table 1 shows the socio-demographic characteristics of immigrants by length of residence in the United States.

**CVD Risk Factors by Length of Residence.** Age- and sex-adjusted prevalence of CVD risk factors by length of residence (Table 2)

**Table 1. Characteristics of Immigrant Population by Length of Residence in the United States**

| Characteristics | % (SE) | | | P-value |
|---|---|---|---|---|
| | <10 years (n=1,554) | 10–<15 years (n=829) | ≥15 years (n=2,847) | |
| Age, mean (SE) | 33.2 (0.4) | 37.0 (0.6) | 49.6 (0.4) | <.001 |
| Age | | | | .001 |
| 18–34 years | 64.3 (1.6) | 46.6 (2.4) | 17.3 (0.9) | |
| 35–49 years | 25.8 (1.4) | 40.5 (2.0) | 35.9 (1.2) | |
| 50–64 years | 7.0 (0.9) | 9.0 (1.4) | 27.3 (1.0) | |
| >65 years | 2.9 (0.6) | 4.0 (0.9) | 19.5 (1.0) | |
| Gender | | | | .848 |
| Women | 49.1 (1.6) | 49.6 (2.0) | 50.2 (1.2) | |
| Marital status | | | | <.001 |
| Married/living with partner | 67.7 (1.6) | 69.1 (1.9) | 70.2 (0.9) | |
| Never married | 25.9 (1.5) | 20.7 (1.8) | 12.1 (0.7) | |
| Previously married | 6.4 (0.8) | 10.3 (1.1) | 17.8 (0.7) | |
| Race/ethnicity | | | | <.001 |
| Hispanic | 48.6 (1.7) | 49.2 (2.4) | 45.5 (1.3) | |
| Non-Hispanic White | 20.3 (1.4) | 14.5 (1.6) | 29.7 (1.1) | |
| Non-Hispanic Black | 8.4 (1.1) | 9.6 (1.6) | 7.2 (0.5) | |
| Non-Hispanic Other | 22.7 (1.6) | 26.7 (2.2) | 17.6 (1.0) | |
| Birth region | | | | <.001 |
| South/Central America | 55.3 (1.7) | 57.8 (2.3) | 52.2 (1.3) | |
| Europe | 10.8 (1.0) | 10.3 (1.5) | 20.4 (0.9) | |
| Africa | 5.3 (0.8) | 2.8 (0.7) | 2.0 (0.3) | |
| Middle East/Asia | 28.7 (1.8) | 29.1 (2.1) | 25.4 (1.1) | |
| Education | | | | .008 |
| <High school | 34.6 (1.5) | 30.8 (2.0) | 30.2 (1.2) | |
| High school graduate | 20.8 (1.3) | 20.4 (1.5) | 22.0 (1.1) | |
| <4 yrs of college | 17.8 (1.3) | 21.6 (1.8) | 23.5 (1.0) | |
| ≥College education | 26.7 (1.5) | 27.2 (2.0) | 24.3 (1.1) | |
| Annual income | | | | <.001 |
| <$ 20,000 | 32.7 (1.6) | 21.8 (1.5) | 20.6 (0.9) | |
| Employment | | | | <.001 |
| Currently working | 63.5 (1.5) | 73.0 (1.8) | 62.2 (1.2) | |
| Health insurance | | | | <.001 |
| No health insurance | 47.3 (1.7) | 36.1 (2.1) | 19.4 (1.0) | |
| Private insurance | 44.7 (1.7) | 54.7 (2.2) | 63.2 (1.2) | |
| Government insurance | 8.0 (1.0) | 9.2 (1.3) | 17.3 (0.9) | |
| Source of usual care | | | | <.001 |
| Yes | 58.6 (1.8) | 71.8 (2.1) | 84.6 (0.9) | |
| Health status | | | | <.001 |
| Excellent/very good | 71.8 (1.2) | 64.0 (2.1) | 55.2 (1.1) | |
| Good | 21.3 (1.1) | 26.8 (1.9) | 29.0 (1.0) | |
| Fair/poor | 6.9 (0.8) | 9.3 (1.2) | 15.8 (0.8) | |
| United States citizen | | | | <.001 |
| Yes | 10.9 (1.1) | 40.5 (2.5) | 72.3 (1.0) | |

*Missing data: BMI=10%, income=7%, physical activity=4%, birth region=3%, and education=2%*

**Table 2. Prevalence of CVD Risk Factors Among Immigrants by Length of Residence Adjusting for Age and Sex**

| CVD risk factors | % (SE) | | | P-value |
|---|---|---|---|---|
| | <10 years (n=1,554) | 10–<15 years (n=829) | ≥15 years (n=2,847) | |
| Obese/overweight | 50.3 (2.2) | 55.0 (2.8) | 57.8 (1.4) | .004 |
| Hypertension | 11.9 (1.6) | 17.7 (2.0) | 18.1 (0.8) | .0004 |
| Hyperlipidemia | 11.6 (1.4) | 13.6 (1.4) | 17.9 (0.9) | .0001 |
| Diabetes mellitus | 5.7(1.2) | 7.8 (1.5) | 6.9 (0.5) | .3624 |
| Sedentary level of activity | 83.2 (1.4) | 83.1 (1.6) | 74.0 (1.2) | <.001 |
| Current smoker | 13.4 (1.2) | 9.3 (1.0) | 16.3 (0.9) | .06 |

showed higher prevalence of obesity, hypertension, and hyperlipidemia with increasing length of residence. However, prevalence of physical inactivity decreased with increasing length of residence.

***CVD Risk Factors by Geographic Region of Birth.*** Age- and sex-adjusted prevalence of CVD risk factors by region of birth (Table 3) showed that prevalence of obesity, hypertension, hyperlipidemia, and physical inactivity differed significantly by region of birth, while prevalence of diabetes and smoking were not significantly different.

***Adjusted Odds of CVD Risk Factors by Length of Residence.*** As shown in Table 4, after adjusting for confounders, there was 31% increased odds of obesity, 59% increased odds of hyperlipidemia, and 39% increased odds of smoking among immigrants who have lived in the United States for ≥15 years relative to those who have lived in the United States for <10 years. In contrast, there was a 40% decreased odds of physical inactivity among immigrants who have lived in the United States for ≥15 years relative to those who have lived in the United States for <10 years. For hypertension and

diabetes, the association with length of residence was not significant.

***Adjusted Odds of CVD Risk Factors by Length of Residence Stratified by Gender.*** Table 4 also shows that the association between obesity/overweight and current smoking with length of residence was significant for women only, whereas the associations for hyperlipidemia and physical inactivity were only significant for men. When variations in the association between length of residence and CVD risk factors by region of birth subgroups were examined by including an interaction term (length of residence × birth region) in all the multivariate models, we found significant interaction only for the outcome variable obesity. Sample size constraints limit further stratified analysis to explain the presence of this interaction.

## DISCUSSION

The results support our hypothesis that among immigrants from diverse ethnic backgrounds, longer duration of residence in the United States is associated with increased odds of multiple cardiovascular risk factors, especially obesity, hyperlipidemia, and cigarette smoking even after adjusting for relevant confounding factors. This association was especially evident in immigrants with ≥15 years of length of residence in the United States relative to those living in the United States for ≤10 years, suggesting a threshold effect. Our results also suggest that longer duration of residence appears to have positive effects on leisure-time physical activity levels (i.e., with

**Table 3. Prevalence of CVD Risk Factors by Geographic Region of Birth of Immigrants Adjusting for Age and Sex**

| CVD risk factors | % (SE) | | | | P-value |
|---|---|---|---|---|---|
| | South/ Central America | Europe/ Russia | Africa | Middle East/ Asia | |
| Obese/overweight | 63.2 (1.1) | 55.9 (2.4) | 58.4 (4.8) | 39.5 (2.1) | <.001 |
| Hypertension | 16.5 (1.8) | 23.3 (1.3) | 15.9 (1.8) | 15.5 (1.4) | .005 |
| Hyperlipidemia | 14.6 (1.5) | 20.9 (1.4) | 14.2 (1.5) | 15.5 (1.3) | .01 |
| Diabetes mellitus | 7.0 (1.7) | 7.0 (1.5) | 5.0 (0.8) | 5.6 (1.4) | .48 |
| Sedentary level of activity | 83.6 (1.6) | 74.2 (1.3) | 78.0 (1.3) | 74.2 (1.7) | <.001 |
| Current smoker | 13.1 (0.7) | 17.8 (1.9) | 13.9 (3.1) | 14.1 (1.1) | .12 |

*South/Central America=Mexico, Central America, Caribbean Islands, South America, Europe/Russia=Europe and Russia, Middle East/Asia= Middle East, India, Asia, South East Asia, and elsewhere*

**Table 4. Adjusted Odds of CVD Risk Factors by Length of Residence Stratified by Gender[†]**

| CVD risk factors | OR (95% CI) | |
|---|---|---|
| | 10–<15 years | ≥15 years |
| Obesity/over weight (n=4,347) | 1.35 (1.06–1.73)* | 1.31 (1.03–1.65)* |
| Male (n=1,989) | 1.27 (0.88–1.82) | 1.25 (0.88–1.78) |
| Female (n=2,358) | 1.47 (1.04–2.07)* | 1.38 (1.01–1.88)* |
| Hypertension (n=4,731) | 1.23 (0.79–1.90) | 1.21 (0.86–1.71) |
| Male (n=2,154) | 1.71 (0.89–3.3) | 1.49 (0.87–2.56) |
| Female (n=2,577) | 0.90 (0.49–1.66) | 1.01 (0.62–1.64) |
| Hyperlipidemia (n=4,731) | 1.12 (0.74–1.69) | 1.59 (1.14–2.22)* |
| Male (n=2,154) | 1.12 (0.60–2.09) | 2.02 (1.23–3.32)* |
| Female (n=2,577) | 1.06 (0.62–1.81) | 1.30 (0.84–2.02) |
| Diabetes mellitus (n=4,735) | 1.10 ( 0.58–2.11) | 1.40 (0.78–2.51) |
| Male (n=2,156) | 1.44 (0.53–3.93) | 1.86 (0.84–4.14) |
| Female (n=2,579) | 0.80 (0.33–1.94) | 1.09 (0.46–2.60) |
| Physical inactivity (n=4,568) | 0.88 (0.66–1.17) | 0.63 (0.47–0.84)* |
| Male (n=2,090) | 0.90 (0.59–1.37) | 0.61 (0.41–0.93)* |
| Female (n=2,478) | 0.89 (0.58–1.38) | 0.66 (0.42–1.03) |
| Current smoking (n=4,731) | 0.77 (0.55–1.08) | 1.39 (1.04–1.85)* |
| Male (n=2,153) | 0.78 (0.52–1.17) | 1.11 (0.76–1.64) |
| Female (n=2,578) | 0.68 (0.32–1.46) | 2.37 (1.39–4.02)* |

*OR=Odds ratio, CI=confidence interval*
[†]Adjusted for age, gender, race/ethnicity, education, income, insurance, marital status, employment, source of care, health status, region of birth, and citizenship status
*Significant OR at P<.05

increasing length of residence in the U.S., immigrants are less likely to be sedentary in their leisure time).

Our findings are consistent with the results from previous studies. Dey and colleagues[6] analyzed pooled NHIS data from 1998–2003 and found higher prevalence of obesity, hypertension, diabetes, current smoking, and cardiovascular diseases among Hispanic immigrants who had lived in the United States for ≥5 years compared with recent immigrants. Kaplan et al.[21] and Abraido-Lanza et al.[22] used NHIS data from 1998 and 1991, respectively, and reported similar association between length of residence and obesity among Hispanic immigrants. Another study that examined health behaviors, morbidity, and cause-specific mortality in U.S. immigrants found a temporal trend in prevalence of cigarette smoking, obesity, hypertension, and chronic health conditions with increasing length of residence in the United States[8]. They also found that the prevalence of these risk factors converged toward those of U.S.-born adults at ≥15 years of length of residence. In another study, Goel et al.[20] found that longer duration of residence in the United States was associated with higher BMI among White, Latino, and Asian immigrants, and at ≥15 years of U.S. residence, BMI levels approached that of U.S.-born adults.

Our results using data from the 2002 NHIS are consistent with these previous results. However, our study is distinct from and adds to the literature by providing an assessment of multiple CVD risk factors that have not been studied previously and looking at differences by gender. Unlike some studies that focused on specific ethnic groups (e.g., Hispanics or Asians) or certain risk factors (e.g., obesity or diabetes), we examined the association between length of residence in the United States and multiple major CVD risk factors among an ethnically diverse group of U.S. immigrants. Also, stratification by gender showed that the odds of obesity/overweight and current smoking were greater for immigrant women with increasing length of residence. These results are consistent with other studies showing greater likelihood of these two health behaviors in Hispanic immigrant women[22–30]. The finding of higher odds of physical activity and hyperlipidemia with increasing length of residence in this ethnically diverse sample is new and an important contribution to the literature.

We also observed a decrease in physical inactivity with increasing length of residence. It is important to note that physical inactivity in the NHIS was defined based on leisure-time activities; hence, the physical inactivity variable does not take into account activities associated with occupation and household work. There are several plausible explanations for this inverse association. First, it is likely that as immigrants live longer in the United States and climb up the economic ladder, they may have more leisure time and access to exercise facilities compared to recent immigrants who may still be struggling to settle into a new environment and have more financial needs. Second, the finding may be due to a "positive acculturation effect". As immigrants live longer in the United States and acculturate to their new environment, they are more likely to adopt health beliefs about the benefits of exercise.

However, the inverse association between length of residence and physical inactivity suggests that a sedentary lifestyle is unlikely to be responsible for the levels of obesity among immigrants as they live longer in the United States. The "ascending/descending limb" hypothesis proposed by Stern et al.[25] may provide a reasonable explanation for this mixed effect (i.e., the association of acculturation with both obesity and increased physical activity levels). This hypothesis suggests that as immigrants strive for affluence (the "ascending limb"), there is a tendency to work multiple jobs, eat unhealthy diets, and have little time for leisure-time physical activity. However, once affluence is achieved (the "descending limb"), there is a trend toward healthier diets and increased leisure-time physical activity. New studies are needed to test the validity of this hypothesis in a diverse population of immigrants.

As with any study, there are limitations to this study that are worth mentioning. First, as this is a cross-sectional study, inferences cannot be made about causal associations. We can conclude that length of residence may be an independent correlate of certain CVD risk factors in U.S. immigrants but cannot establish a causal relationship between these risk factors and length of residence. Second, odds ratios derived from our logistic regression overestimates the risk ratios as the outcomes of interest (prevalence of CVD risk factors) are not rare in the immigrant population. Although our effects are only of modest sizes, they are similar to the results of other population-based studies in this area[8,22]. Third, because CVD risk factors were based on self-report, there is a potential for recall bias and, also because surveys were administered in English and Spanish, language barriers might affect the response of participants. However, nonresponse by language of administration was not available, so this effect cannot be ascertained. Also, it is difficult to determine whether language and cultural barriers influenced accuracy of self-reported weight, height, or other health behaviors.

Fourth, sample size constraints limited our ability to conclusively determine whether CVD risk factors were significantly different within ethnic groups or across geographic regions of birth. These questions need to be examined in future studies. Fifth, we used length of residence as a proxy for acculturation. Although several prior studies have used this measure for assessing acculturation in relation to health behaviors, especially in Hispanic immigrants[8,21,22,26,27], it is not a true measure of the more complex acculturation process[28]. Finally, we used "immigrant" and "foreign-born" interchangeably in our study. Thus, naturalized citizens, legal permanent residents, illegal immigrants, and nonimmigrants (students, visitors, guest workers, etc.) were all included in the same category.

The implication of this study is that compared to recent immigrants (i.e., those with low acculturation), earlier immigrants (i.e., those with high acculturation) appear to have higher prevalence of CVD risk factors like obesity, hypertension, hyperlipidemia, and current smoking but have lower prevalence of physical inactivity. This suggests that length of residence (a proxy for acculturation) is associated with increased odds of certain CVD risk factors among U.S. immigrants. It is crucial to identify acculturation factors that have negative impact on health behaviors and increase the odds of having CVD risk factors in the large and growing U.S. immigrant population. Prospective studies are needed to better understand how acculturation influences health behaviors across different immigrant racial/ethnic groups. In addition, intervention studies that test tailored strategies to improve lifestyle behaviors across diverse racial/ethnic groups of immigrant are needed.

In conclusion, among immigrants from diverse ethnic backgrounds, longer length of residence in the United States is associated with increased odds of multiple cardiovascular risk

factors including obesity, hyperlipidemia, and cigarette smoking even after adjusting for relevant confounding factors.

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