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Allostatic Load, Unhealthy Behaviors, and Depressive Symptoms by Birthplace Among Older Adults in the Sacramento Area Latino Study on Aging (SALSA)

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Abstract

Objective: To assess whether unhealthy behaviors moderated the relationship between allostatic load (AL) and future significant depressive symptoms (SDSs) among 1,789 older Latinos.

Method: Longitudinal data included baseline AL, three unhealthy behaviors (UBs), and 2-year follow-up SDS. Multivariable logistic regression analyses, stratified by birthplace (U.S. vs. foreign born), modeled the effects of AL, UB count (range = 0–3), and their interaction on follow-up SDS.

Results: Compared with U.S.-born, foreign-born participants engaged in fewer UBs (0.52 vs. 0.60 behaviors, $p = .01$) and had higher baseline SDS (31% vs. 20%, $p < .001$). Among foreign-born participants, the effect of AL on future SDS (adjusted odds ratios [aORs]; 95% confidence interval [CI]) significantly increased across UB counts of 0 to 3: 1.06 [0.83, 1.35], 1.46 [1.14, 1.87], 2.00 [1.18, 3.41], and 2.75 [1.18, 6.44], respectively.

Discussion: Among foreign-born Latinos, these results were most pronounced for women and adults above age 80, which may represent higher risk groups requiring more intensive screening for depression.

Keywords

physiological stress; allostasis; health behavior; depression; Hispanic Americans

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Supplemental Material

Supplemental material for this article is available online.

Life stressors experienced during adulthood can lead to an increased likelihood of depression over time (Hammen, 2005; Paykel, 2003). For racial/ethnic minorities, such as Latinos, inequalities in socioeconomic opportunities and environmental conditions may lead to higher levels of chronic stress and subsequently mental illness. Among older adults, Latinos report a greater level of chronic stress compared with Whites (Rodriquez, Gregorich, Livaudais-Toman, & Pérez-Stable, 2017). In addition, the 12-month prevalence of major depression is higher among older Latinos (8.2%) compared with older Whites (5.0%; Jimenez, Alegria, Chen, Chan, & Laderman, 2010). Social determinants could contribute to inequities in mental health via their impact on health behaviors. Based on previous analyses, older Latinos report engaging in significantly more unhealthy behaviors than Whites (Rodriquez et al., 2017). Research among Latinos on the relationships between chronic stress and health risk behaviors on mental health outcomes is limited. The higher prevalence of major depression among older Latinos may be partially explained by differential effects of stress and health risk behaviors.

Unhealthy behaviors, singularly or in combination, may influence the relationship between chronic stress and depression (Jackson, Knight, & Rafferty, 2010; Lipton, 1997; Rodriquez et al., 2017). The Environmental Affordances Model has been proposed as a theoretical framework, which explains how chronic stress and health risk behaviors may interact to affect both physical and mental health (Mezuk et al., 2013). The model posits that the effect of chronic stress on depression is attenuated by unhealthy behaviors, particularly among African Americans. In contrast, among Latino older adults, one study found that those who experienced more chronic stress and had more unhealthy behaviors were more likely to experience future significant depressive symptoms (Rodriquez et al., 2017). Another study found that foreign-born Mexicans who experienced chronic stress reported more depression if they engaged in excessive alcohol use (Lipton, 1997). Research has suggested biological mechanisms that partially explain the relationships of chronic stress with substance use, unhealthy food consumption, and limited physical activity (Dallman et al., 2003; Koob et al., 1998; Lutz, Lochbaum, Lanning, Stinson, & Brewer, 2007; Piazza & Le Moal, 1998; Wadsworth, 2015). These findings warrant research to understand how the social and biological mechanisms that link chronic stress, unhealthy behaviors, and depression may differ by race/ethnicity.

Research among Mexican Americans found that the relationships between life stressors, such as discrimination and acculturative stress, and depressive symptoms differed by birthplace (Finch, Kolody, & Vega, 2000). A more recent study among a diverse sample of Latinos had similar findings regarding exposure to stressful life events and depressive symptoms comparing foreign born with U.S. born (Tillman & Weiss, 2009). There is a need to expand our knowledge of the longitudinal effects of life stressors, health risk behaviors, and their contributions to mental health disparities among Latinos by birthplace.

This study used secondary data from two waves of the Sacramento Area Latino Study on Aging (SALSA) to assess whether unhealthy behaviors moderated the relationship between cumulative chronic stress, measured by allostatic load, and future significant depressive symptoms among Latinos by birthplace. Allostatic load has been associated with mental health outcomes (Schulz et al., 2012; Seeman, Singer, Rowe, Horwitz, & McEwen, 1997),

and based on previous findings among Latinos, we hypothesized that engaging in a greater number of unhealthy behaviors would intensify the relationship between allostatic load (i.e., chronic stress) and future significant depressive symptoms for foreign-born Latinos.

Method

Study Design and Sample

This was a secondary analysis of data from SALSA (National Archive of Computerized Data on Aging, n.d.). Participants were 1,786 older Latinos, mostly of Mexican origin, from six California counties (Sacramento, Yolo, Sutter, Placer, Solano, and Yuba) recruited between March 1998 and June 1999 to participate in a longitudinal cohort study. Based on the 1990 U.S. Census, census tracts with greater than 10% Latino composition were selected for enumeration of Latino households. Participants were eligible if they selfidentified as being of Latino or Hispanic ancestry, were at least 60 years old, and spoke English, Spanish, or both as primary languages. Interviews were conducted in participants' homes by bilingual/bicultural field staff to obtain demographic, health, and functional status data. A brief clinical assessment was conducted, including anthropometry, blood pressure measurement, and blood draw. Biannual telephone interviews were conducted to update current health status and medication use and a follow-up visit was conducted at 24 to 30 months. The final sample included participants who completed interviews and assessments at both baseline and follow-up visits. Further description of the study procedures has been published (Haan et al., 2003). SALSA was approved by the institutional review boards of the collaborating institutions.

Measures

We used allostatic load as a biomarker of stress. Using 10 established biological indicators (Beckie, 2012), a continuous allostatic load variable was calculated at baseline as an index of overall physiological dysregulation due to the cumulative burden of stress on the body. The index was originally developed using data from the MacArthur Studies of Successful Aging (Seeman et al., 1997). Indicators were (a and b) systolic and diastolic blood pressure, (c) waist–hip circumference ratio, (d) total serum cholesterol, (e) high-density lipoprotein (HDL) cholesterol, (f) ratio of total to HDL cholesterol, (g) interleukin-6, (h) C-reactive protein, (i) albumin, and (j) estimated creatinine clearance based on the 2009 Chronic Kidney Disease Epidemiology Collaboration equation for estimating glomerular filtration rate expressed for specified sex and serum creatinine level (Levey et al., 2009).

Allostatic load risk categories included low, moderate, or high risk using clinically relevant cut points for all biomarkers except interleukin-6, which was based on tertiles. Clinically relevant low, moderate, and high cut points, respectively, are as follows: systolic blood pressure <120 mm Hg, 120 to 149 mm Hg, and ≥150 mm Hg; diastolic blood pressure <80 mm Hg, 80 to 89 mm Hg, and ≥90 mm Hg; waist–hip circumference ratio for men ≤0.95, >0.95 to <1.0, and ≥1.0; waist–hip circumference ratio for women, ≤0.80, >0.80 to <0.85, and ≥0.85; total cholesterol <200 mg/dL, 200 to 239 mg/dL, and ≥240 mg/dL; HDL cholesterol ≥60 mg/dL, 40 to 59 mg/dL, and <40 mg/dL; total/HDL cholesterol ratio <5, 5 to <6, and ≥6; interleukin-6 <2.9, 2.9 to 5.0, and >5.0; C-reactive protein <1 mg/L, 1 to 3

mg/L, and >3 mg/L; albumin ≥3.8 mg/L, 3 to <3.8 mg/L, and <3 mg/L; and creatinine clearance ≥60 mL/min/1.73 m^2, 30 to 59 mL/min/1.73 m^2, and <30 mL/min/1.73 m^2. Higher values correspond to higher risk of all biomarkers except for HDL cholesterol, albumin, and creatinine clearance, where lower values indicate a higher risk.

By assigning zero points for low risk, a half point for moderate risk, and 1 point for high risk, an allostatic load score (range = 0–10) was calculated by summing the values for all 10 biomarkers. Participants taking medications that may have influenced the level of a biological indicator were not subject to adjustment because improved levels of any indicator(s) would successfully reduce the effects of stress on regulatory systems and subsequently lower allostatic load.

Three self-reported unhealthy behaviors were assessed at baseline: current cigarette smoking, excessive/binge drinking of alcohol, and body mass index (BMI) as a proxy measure of poor diet and physical inactivity. Current smoking was defined as smoking in the last 30 days. The following established definitions (National Institute on Alcohol Abuse and Alcoholism, n.d.) were used to define excessive drinking: for those <65 years old, >2 drinks per day on average or >14 drinks per week for men and >1 drink per day on average or >7 drinks per week for women; for women and men ≥65 years old, >1 drink per day on average or >7 drinks per week. Binge drinking was defined as ≥4 and ≥5 drinks of alcohol per day for women and men, respectively. Height and weight were determined by physical examination and used to calculate BMI. Levels of obesity were defined as follows: normal/not obese = BMI <25 kg/m^2, overweight = BMI ≥25 kg/m^2 to BMI <30 kg/m^2, and obese = BMI ≥30 kg/m^2. A count of the unhealthy behaviors, ranging from 0 to 3, was created by summing the “yes” responses of current smoking, excessive or binge drinking, and being obese.

Depressive symptoms were the outcomes of interest and were assessed at baseline and follow-up visits using the 20-item Center for Epidemiologic Studies–Depression (CES-D) Scale (Radloff, 1977). Items assessed the frequency of depressive symptoms using a four-level response scale (*never, little of the time, some of the time*, and *most or all the time*, coded as 0, 1, 2, and 3, respectively). The sum of the items represents the total score with a possible range of 0 to 60. A standard cut point of ≥16 for adults was used as an indicator of significant depressive symptoms (Gonzalez, Haan, & Hinton, 2001). Longitudinal depressive symptom outcomes were restricted to those collected at Visit 2 (Jackson et al., 2010; Rodriquez et al., 2017).

Demographic covariates were age, birthplace, gender, educational attainment (less than ninth grade, ninth to 12th grade, high school graduate or equivalent, and some college or higher), household income, and language preference and were assessed at baseline by self-report and considered as potential covariates.

Statistical Analyses

T tests and chi-square tests were used to examine bivariate associations between individual-level characteristics and birthplace. We fit bivariate, multivariable, and multinomial logistic regression models for the overall sample and stratified by birthplace to assess whether

engaging in one or more unhealthy behaviors would intensify the relationship between allostatic load and significant depressive symptoms among Latinos.

Bivariate relationships between allostatic load at baseline, unhealthy behaviors at baseline, and significant depressive symptoms at follow-up (i.e., 24–30 months after baseline) were modeled using logistic and linear regression, stratified by birthplace, and fit prior to the construction of multivariable models.

Multivariable models estimated the effects of allostatic load score and unhealthy behavior count at baseline, as well as their interaction, on predicting significant depressive symptoms at follow-up, controlling for age, gender, educational attainment, and significant depressive symptoms at baseline (Figure 1). The interaction term between allostatic load score and unhealthy behavior count in each model tested our moderation hypothesis. Approximately 12% of participants were missing data for at least one variable. Listwise deletion was used to exclude participants with missing data for any variable. Analyses were conducted using SAS 9.4 (SAS Institute, Inc., Cary, North Carolina).

Results

The baseline sample of 1,789 Latinos comprised 871 U.S. born (56.6% women) and 908 foreign born participants (60.4% women; Table 1). U.S. born participants were similar in age to their foreign born counterparts (70.1 years vs. 71.2 years, $p = .001$). Almost 80% of foreign born participants reported less than ninth-grade education, whereas most U.S. born participants (58.5%) obtained a ninth-grade education or higher ($p < .0001$). Current smoking ($p = .95$), excessive drinking ($p = .13$), and binge drinking ($p = .25$) did not differ significantly by birthplace. Obesity was common in both groups (44.6% of U.S. born vs. 39.8% of foreign born; $p = .07$). U.S. born participants had a higher mean number of unhealthy behaviors than foreign born participants (0.60 vs. 0.52, $p = .01$). The prevalence of significant depressive symptoms at baseline was higher among foreign born than U.S. born participants (30.6% vs. 20.2%, $p < .0001$). At follow-up, this difference narrowed but remained significantly different (26.9% vs. 21.4%, $p = .03$).

Biomarkers of Stress and Allostatic Load

Overall, a quarter of participants had elevated systolic blood pressure (≥150 mm Hg or high risk), with similar rates across birthplace groups (24.6% U.S. born vs. 25.0% foreign born, $p = .83$; Table 2). About 10% of the total sample had elevated diastolic blood pressure, with similar rates by birthplace (10.8% U.S. born vs. 9.7% foreign born, $p = .74$). Less than half of participants were categorized as highest risk on waist–hip circumference ratio, with no differences by birthplace (44.4% U.S. born vs. 46.3% foreign born, $p = .70$). The proportion classified as highest risk based on total cholesterol levels (≥240 mg/dL) was similar for foreign born and U.S. born groups (22.2% vs. 21.9%, $p = .30$). Based on interleukin-6 levels, a greater proportion of foreign born than U.S. born Latinos were classified as lowest risk (36.8% vs. 30.0%, $p<.01$). Overall, half of participants were categorized as being high risk on C-reactive protein levels, with greater risk among U.S. born than foreign born participants (56.6% vs. 49.3%, $p = .01$). Overall, most participants were classified as lowest risk based on albumin and creatinine clearance levels, with no significant differences

observed by birthplace. Mean values for the allostatic load score were similar for U.S. born (*M* [*SD*] = 3.96 [1.32]) and foreign born (*M* [*SD*] = 3.82 [1.38], *p* = .06) participants.

Associations Between Allostatic Load and Unhealthy Behaviors

As for individual unhealthy behaviors, current smoking was associated with a higher allostatic load score among foreign born Latinos. Allostatic load score was significantly associated with obesity in U.S. born and foreign born groups (Table 3). Regarding the unhealthy behavior count, a greater allostatic load score was associated with significantly higher odds of engaging in one (adjusted odds ratio [aOR] = 1.49, 95% confidence interval [CI] = [1.36, 1.63]) and two unhealthy behaviors (aOR = 1.53, 95% CI = [1.29, 1.83]), but not three unhealthy behaviors (aOR = 1.77, 95% CI = [0.97, 3.24]), compared with those who did not engage in any of these three unhealthy behaviors. Associations that were significant were consistent for both U.S. born (unhealthy behavior count = 1, aOR = 1.47, 95% CI = [1.29, 1.67]; unhealthy behavior count = 2, aOR = 1.47, 95% CI = [1.17, 1.86]) and foreign born (unhealthy behavior count = 1, aOR = 1.52, 95% CI = [1.34, 1.73]; unhealthy behavior count = 2, aOR = 1.55, 95% CI = [1.17, 2.05]) participants.

Main Effects

Greater allostatic load score was associated significantly with follow-up depressive symptoms at the mean unhealthy behavior count (aOR = 1.17, 95% CI = [1.03, 1.33], data not shown). Also, a higher unhealthy behavior count at baseline was significantly associated with follow-up depressive symptoms at the mean allostatic load score (aOR = 0.98, 95% CI = [0.18, 0.99], data not shown).

Interaction Effects

Odds ratios for the interaction effects were estimated from the model that included unhealthy behavior count (Table 4). In the overall sample, the interactive effect of allostatic load on significant depressive symptoms strengthened with increasing numbers of unhealthy behaviors (unhealthy behavior count = 0, aOR = 1.02, 95% CI = [0.86, 1.21], *p* = .80; unhealthy behavior count = 1, aOR = 1.28, 95% CI = [1.09, 1.50], *p* = .003; unhealthy behavior count = 2, aOR = 1.61, 95% CI = [1.16, 2.23], *p* = .005; unhealthy behavior count = 3, aOR = 2.01, 95% CI = [1.19, 3.40], *p* = .009; Table 4), respectively. In models stratified by birthplace, an interaction effect was only observed among foreign born participants (unhealthy behavior count = 0, aOR = 1.06, 95% CI = [0.83, 1.35], *p* = .64; unhealthy behavior count = 1, aOR = 1.46, 95% CI = [1.14, 1.87], *p* = .003; unhealthy behavior count = 2, aOR = 2.00, 95% CI = [1.18, 3.41], *p* = .01; unhealthy behavior count = 3, aOR = 2.75, 95% CI = [1.18, 6.44], *p* = .02).

Other Predictors of Depressive Symptoms

Those who were 80 years of age or older, regardless of birthplace, were more likely to report depressive symptoms at follow-up versus those who were 60 to 69 years old. Compared with foreign born men, foreign born women were more than two and a half times more likely (95% CI = [1.54, 4.64]) to report depressive symptoms at follow-up. Among U.S. born participants, those with some college or higher education were less likely than their

counterparts with less than a ninth-grade education (aOR = 0.45, 95% CI = [0.23, 0.85]) to report depressive symptoms at follow-up. Among foreign born participants, only those with a ninth grade to high school education were less likely to report depressive symptoms at follow-up compared with those with less than a ninth-grade education (aOR = 0.38, 95% CI = [0.15, 0.99]). Among both groups, participants who reported significant depressive symptoms at baseline were at least 4 times more likely to experience significant depressive symptoms at follow-up compared with those who did not.

Discussion

Our purpose was to assess the effects of allostatic load, the number of unhealthy behaviors, and their interaction on depressive symptoms longitudinally and whether these relationships varied by birthplace among Latinos. Results showed that higher allostatic load increased the risk of future significant depressive symptoms, and that the effect of allostatic load on depressives symptoms increased significantly with more unhealthy behaviors among foreign born Latinos. We also found that foreign born women and adults ≥80 years old were at a greater risk of experiencing significant depressive symptoms in the future, after accounting for allostatic load and unhealthy behaviors. Our data contribute to increased understanding of the effects of cumulative physiologic stress and three unhealthy behaviors on future depressive symptoms and emphasize the importance of evaluating Latinos by birthplace. These findings indicate that the Environmental Affordances Model may not apply to Latinos.

Grounded in neurobiological research on stress and health behavior and sociological theory, the Environmental Affordances Model attempts to explain how life stressors at the individual and societal levels interact with unhealthy behaviors to potentially attenuate the effect of stress on health among racial/ethnic minorities (Mezuk et al., 2013). Previous research has debated whether African Americans engage in unhealthy behaviors to reduce the effect of chronic stress on depression (Bates, Barnes, & Keyes, 2011; Boardman & Alexander, 2011; Mezuk et al., 2010). Two studies did not find an interaction effect between race, chronic stress, and unhealthy behaviors on depression hypothesized by the Environmental Affordances Model (Keyes, Barnes, & Bates, 2011; Walsh, Senn, & Carey, 2013). The nature of the interaction effect between allostatic load and unhealthy behaviors on the risk of future significant depressive symptoms among foreign born Latinos is inconsistent with the Environmental Affordances Model, but is supported by prior research on depressive symptoms among older Latinos and foreign born Mexicans (Lipton, 1997; Rodriquez et al., 2017). Our findings suggest that unhealthy behaviors may place foreign born Latinos at an increased risk of future significant depressive symptoms over time when they are chronically stressed. Therefore, this model may be directly relevant for African Americans (Jackson et al., 2010; Mezuk et al., 2010), but may only be relevant for depressive symptoms among Latinos.

Women, in particular those who were foreign born, were at a higher risk of future significant depressive symptoms. These observations may indicate contributing factors of stress from immigration and possible changes in traditional gender roles. Previous research has established that women are about twice as likely as men to report symptoms of depression

(Kuehner, 2017). Depression or significant depressive symptoms were found to be more prevalent among older foreign born Latinos than their U.S. born counterparts (Gonzalez et al., 2001; Jimenez et al., 2010; Rote, Chen, & Markides, 2015). Given that the SALSA cohort was almost entirely comprised of older Mexican Americans (Gonzalez et al., 2001), our findings suggest that the higher risk of depressive symptoms among foreign born women may be due to cumulative deleterious factors that are yet unexplained.

We also observed a higher risk of significant depressive symptoms among adults 80 years of age and older. In the general population, depressive symptoms are either less frequent or similar among older adults compared with middle-aged adults (Blazer, 2003; Haigh, Bogucki, Sigmon, & Blazer, 2018). However, older Mexican Americans may experience depression more frequently than other racial/ethnic groups for unclear reasons, with a possible explanation being increasing disillusionment with longer time in the United States (Blazer, 2003; Gonzalez et al., 2001). Our results support a longitudinal relationship between depressive symptoms, allostatic load, and unhealthy behaviors and risk of future significant depressive symptoms among foreign born elderly Mexican Americans.

Mental health and unhealthy behaviors covary with birthplace, so birthplace is an important factor to include when studying these constructs among Latinos. Among Mexican Americans, the prevalence of mood disorders, such as major depression, has been found to be lower among foreign born adults than U.S. born adults (Grant et al., 2004). Among older Latinos, foreign born adults are significantly less likely to report using substances compared with U.S. born adults (Jimenez et al., 2010). Disaggregating Latinos by birthplace can reveal findings that would have been obscured using aggregated data. Behavioral health interventions need to attend to such differences by birthplace among Latinos when designing prevention and treatment interventions.

The main limitation of the present study is that we assessed self-reported depressive symptoms, which may be more fallible than a clinical diagnosis of depression. The age range of study participants may have prevented us from observing relationships that may exist among middle-aged or younger adults. In addition, not being able to assess poor diet and physical inactivity separately may have limited the effect of the unhealthy behavior count. Finally, the time period of 24 to 30 months between baseline and follow-up assessments may not be the optimal assessment period in which to investigate the relationships targeted in these analyses. Future research may improve upon our analysis by incorporating a clinically relevant measure of depression and investigating the relationships between allostatic load, unhealthy behaviors, and depression among younger to middle-aged U.S. born Latinos with a more refined follow-up time frame.

In summary, using longitudinal data, our findings suggest that the effect of chronic stress on significant depressive symptoms increased with greater counts of unhealthy behaviors among older foreign born Latinos, thus improving our understanding of the mechanisms between chronic stress and mental health. Our findings contribute to the identification of a population group that may require more intensive screening for biomarkers of stress and unhealthy behaviors in primary care settings due to their higher risk of subsequent depression.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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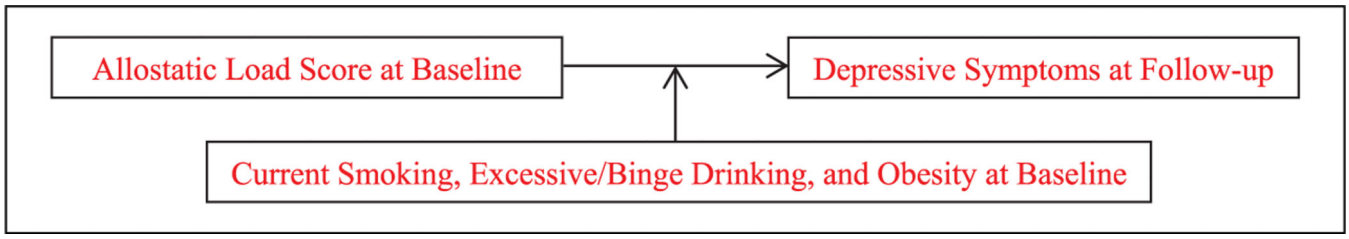

Figure 1.
Hypothesized relationships between allostatic load score and depressive symptoms moderated by three unhealthy behaviors.

Table 1.

Demographics and Unhealthy Behaviors at Baseline (1998–1999) and Significant Depressive Symptoms at Baseline and Follow-Up (24–30 Months After Baseline) by Birthplace: Sacramento Area Latino Study on Aging.

Characteristics	Total *n* = 1,789 100%[a]	U.S. born *n* = 871 49%[a]	Foreign born *n* = 908 51%[a]	*p* value
Age, *M* (*SD*)	70.6 (7.1)	70.1 (6.4)	71.2 (7.7)	.001
Age, *n* (%)				
60–69 years	919 (51.5)	465 (53.4)	447 (49.2)	<.001
70–79 years	683 (38.2)	348 (40.0)	335 (36.9)	
≥80 years	184 (10.3)	58 (6.7)	126 (13.9)	
Women, *n* (%)	1,044 (58.4)	493 (56.6)	548 (60.4)	.11
Education, *n* (%) Less than ninth grade	1,083 (60.9)	361 (41.5)	722 (79.5)	<.001
Ninth grade to high school	177 (10.0)	119 (13.7)	58 (6.4)	
High school graduate or equivalent	225 (12.7)	166 (19.1)	59 (6.5)	
Some college or higher	294 (16.5)	225 (25.8)	69 (7.6)	
Current smoking, *n* (%)	203 (11.4)	99 (11.4)	104 (11.5)	.95
Excessive[b] or binge[c] drinking, *n* (%)				
Excessive drinking[b]	103 (5.9)	58 (6.8)	45 (5.1)	.13
Binge drinking[c]	24 (1.4)	9 (1.0)	15 (1.7)	.25
Obesity, *n* (%)				.07
Normal: BMI < 25 kg/m^2	311 (19.1)	140 (17.3)	171 (21.0)	
Overweight: 25 kg/m^2 ≤ BMI < 30 kg/m^2	629 (38.7)	309 (38.1)	320 (39.3)	
Obese: BMI ≥ 30 kg/m^2	686 (42.2)	362 (44.6)	324 (39.8)	
Unhealthy behavior count,[d] *M* (*SD*)	0.56 (0.62)	0.60 (0.64)	0.52 (0.61)	.01
Unhealthy behavior count,[d] *n* (%)				.10
0	902 (51.1)	417 (48.4)	485 (53.6)	
1	748 (42.3)	379 (44.0)	369 (40.8)	
2	109 (6.2)	62 (7.2)	47 (5.2)	
3	8 (0.5)	4 (0.5)	4 (0.4)	
Significant depressive symptoms at baseline, *n* (%)	439 (25.5)	172 (20.2)	267 (30.6)	<.001
Significant depressive symptoms at follow-up, *n* (%)	279 (24.0)	130 (21.4)	149 (26.9)	.03

Note. Center for Epidemiologic Studies–Depression Scale score of 16 or greater. BMI = body mass index.

[a]Percentages based on nonmissing values.

[b]For <65 years old: >2 drinks per day or >14 drinks per week on average for men and >1 drinks per day or >7 drinks per week on average for women; for women and men ≥65 years old: >1 drink per day or >7 drinks per week on average.

[c]Based on ≥4 drinks per day for women and ≥5 drinks per day for men.

[d] Assigned 1 point each for current smoking, excessive or binge drinking, or being obese.

Table 2.

Biomarkers of Stress and Allostatic Load Score at Baseline by Birthplace: Sacramento Area Latino Study on Aging, 1998 to 1999.

Characteristics	Total *n* = 1,789 100%[a]	U.S. born *n* = 871 49%[a]	Foreign born *n* = 908 51%[a]	*p* value
Systolic blood pressure (mm Hg)				
Low risk (<120)	236 (14.3)	122 (14.9)	114 (13.8)	.83
Moderate risk (120–149)	1,002 (60.9)	497 (60.5)	505 (61.2)	
High risk (≥150)	408 (24.8)	202 (24.6)	206 (25.0)	
Diastolic blood pressure (mm Hg)				
Low risk (<80)	1,038 (63.1)	513 (62.5)	525 (63.6)	.74
Moderate risk (80–89)	439 (26.7)	219 (26.7)	220 (26.7)	
High risk (≥90)	169 (10.3)	89 (10.8)	80 (9.7)	
Waist–hip circumference ratio				
Low risk (men: ≤0.95, women: ≤0.80)	505 (30.7)	253 (30.9)	252 (30.5)	.70
Moderate risk (men: >0.95 to <1.0, women: >0.80 to <0.85)	395 (24.0)	203 (24.8)	192 (23.2)	
High risk (men: ≥1.0, women: ≥0.85)	746 (45.3)	364 (44.4)	382 (46.3)	
Total cholesterol (mg/dL)				
Low risk (<200)	634 (38.8)	332 (40.5)	302 (37.0)	.30
Moderate risk (200–239)	641 (39.2)	308 (37.6)	333 (40.8)	
High risk (≥240)	360 (22.0)	179 (21.9)	181 (22.2)	
HDL cholesterol (mg/dL)				
Low risk (≥60)	389 (23.8)	197 (24.1)	192 (23.6)	.97
Moderate risk (40–59)	988 (60.5)	493 (60.2)	495 (60.7)	
High risk (<40)	257 (15.7)	129 (15.8)	128 (15.7)	
Total/HDL cholesterol ratio				
Low risk (<5)	1,216 (74.4)	621 (75.8)	595 (73.0)	.24
Moderate risk (5 to <6)	315 (19.3)	154 (18.8)	161 (19.8)	
High risk (≥6)	103 (6.3)	44 (5.4)	59 (7.2)	
Interleukin-6[b]				
Low risk (<2.9)	520 (33.3)	236 (30.0)	283 (36.8)	.01
Moderate risk (2.9–5.0)	522 (33.4)	266 (33.8)	251 (32.6)	
High risk (>5.0)	520 (33.3)	284 (36.1)	235 (30.6)	
C-reactive protein (mg/L)				
Low risk (<1)	286 (18.3)	132 (16.8)	154 (20.0)	.01
Moderate risk (1–3)	448 (28.7)	209 (26.6)	236 (30.7)	
High risk (>3)	828 (53.0)	445 (56.6)	379 (49.3)	
Albumin (mg/L)				
Low risk (≥3.8)	1,135 (69.6)	550 (67.3)	585 (71.9)	.12
Moderate risk (3 to <3.8)	476 (29.2)	255 (31.2)	221 (27.2)	
High risk (<3)	20 (1.2)	12 (1.5)	8 (1.0)	

Characteristics	Total *n* = 1,789 100%[a]	U.S. born *n* = 871 49%[a]	Foreign born *n* = 908 51%[a]	*p* value
Creatinine clearance (mL/min/1.73 m^2)[c]				
Low risk (≥60)	1,395 (85.5)	689 (84.3)	706 (86.7)	.64
Moderate risk (30–59)	200 (12.3)	108 (13.2)	92 (11.3)	
High risk (<30)	36 (2.2)	20 (2.5)	16 (2.5)	
Allostatic load score[a,d] *M* (*SD*)	3.89 (1.35)	3.96 (1.32)	3.82 (1.38)	.06

Note. HDL = high-density lipoprotein.

[a]Percentages based on nonmissing value.

[b]Cut points based on tertiles.

[c]Based on the 2009 Chronic Kidney Disease Epidemiology Collaboration equation for estimating glomerular filtration rate expressed for specified sex and serum creatinine level.

[d]Assigned 0.5 points for each biomarker categorized as moderate risk and 1 point for each biomarker categorized as high risk. Allostatic load score range = 0 to 10.

Table 3.

Associations Between Allostatic Load Score and Unhealthy Behaviors at Baseline: Sacramento Area Latino Study on Aging, 1998 to 1999.

	Total		U.S. born		Foreign born	
Unhealthy behavior	**aOR[a]**	**95% CI**	**aOR[a]**	**95% CI**	**aOR[a]**	**95% CI**
Current smoking	1.15	[1.02, 1.30]	1.09	[0.91, 1.31]	1.22	[1.03, 1.45] *
Excessive or binge drinking	0.96	[0.69, 1.32]	1.22	[0.76, 1.95]	0.89	[0.59, 1.33]
Obese	1.55	[1.42, 1.70] ***	1.53	[1.35, 1.74] ***	1.56	[1.37, 1.77] ***
Unhealthy behavior count[b,c] = 0	Reference		Reference		Reference	
Unhealthy behavior count[b,c] = 1	1.49	[1.36, 1.63] ***	1.47	[1.29, 1.67] ***	1.52	[1.34, 1.73] ***
Unhealthy behavior count[b,c] = 2	1.53	[1.29, 1.83] ***	1.47	[1.17, 1.86] ***	1.55	[1.17, 2.05] **
Unhealthy behavior count[b,c] = 3	1.77	[0.97, 3.24]	1.96	[0.61, 6.23]	1.95	[0.91, 4.17]

Note. Allostatic load score included systolic and diastolic blood pressure, waist–hip circumference ratio, total cholesterol and HDL cholesterol, total/HDL cholesterol ratio, interleukin-6, C-reactive protein, albumin, and creatinine clearance. Respondents were assigned 0.5 points for each biomarker categorized as moderate risk and 1 point for each biomarker categorized as high risk. Allostatic load score range = 0–10. aOR = adjusted odds ratio; CI = confidence interval; HDL = high-density lipoprotein.

[a]Adjusted for age, gender, education, and significant depressive symptoms at baseline.

[b]Unhealthy behavior count included current smoking, excessive or binge drinking, and being obese.

Respondents were assigned 1 point for each behavior reported.

[c]Modeled using multinomial logistic regression.

*$p < .05$.

**$p < .01$.

***$p < .001$.

Table 4.

Multivariable Logistic Regression Results Predicting Significant Depressive Symptoms at Follow-Up (24–30 Months After Baseline) by Birthplace: Sacramento Area Latino Study on Aging, 1998 to 1999.

	Total		U.S. born		Foreign born	
Independent variables at baseline	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Interaction terms (Allostatic Load[a] × Unhealthy Behavior[b])[d]						
Allostatic load score at unhealthy behavior count = 0	1.02	[0.86, 1.21]	0.95	[0.75, 1.20]	1.06	[0.83, 1.35]
Allostatic load score at unhealthy behavior count = 1	1.28	[1.09, 1.50]**	1.09	[0.88, 1.36]	1.46	[1.14, 1.87]**
Allostatic load score at unhealthy behavior count = 2	1.61	[1.16, 2.23]**	1.26	[0.81, 1.96]	2.00	[1.18, 3.41]*
Allostatic load score at unhealthy behavior count = 3	2.01	[1.19, 3.40]**	1.45	[0.72, 2.93]	2.75	[1.18, 6.44]*
Covariates						
Age, categorical						
60–69 years		Reference		Reference		Reference
70–79 years	0.93	[0.67, 1.30]	0.90	[0.56, 1.43]	1.04	[0.63, 1.74]
≥80 years	2.27	[1.32, 3.89]**	2.60	[1.06, 6.39]**	2.62	[1.27, 5.40]**
Gender						
Men		Reference		Reference		Reference
Women	1.80	[1.27, 2.55]**	1.32	[0.83, 2.10]	2.68	[1.54, 4.64]***
Education						
Less than ninth grade		Reference		Reference		Reference
Ninth grade to high school	0.72	[0.43, 1.20]	0.99	[0.51, 1.89]	0.38	[0.15, 0.99]*
High school graduate or equivalent	0.91	[0.58, 1.44]	1.08	[0.62, 1.89]	0.34	[0.10, 1.12]
Some college or higher	0.52	[0.32, 0.85]**	0.45	[0.23, 0.85]*	0.69	[0.29, 1.66]
Depressive symptoms[c] at baseline						
Not significant		Reference		Reference		Reference
Significant	5.13	[3.70, 7.11]***	4.71	[2.90, 7.64]***	5.75	[3.60, 9.16]***

Note. OR = odds ratio; CI = confidence interval; HDL = high-density lipoprotein.

[a] Allostatic load score included systolic and diastolic blood pressure, waist-hip circumference ratio, total and HDL cholesterol, total/HDL cholesterol ratio, interleukin-6, C-reactive protein, albumin, and creatinine clearance. Respondents were assigned 0.5 points for each biomarker categorized as moderate risk and 1 point for each biomarker categorized as high risk. Allostatic load score range = 0 to 10.

[b] Unhealthy behavior count included current smoking, excessive or binge drinking, and being obese. Respondents were assigned 1 point for each behavior reported.

[c] Based on a score of 16 or greater on the Left for Epidemiologic Studies–Depression Scale

[d] Each odds ratio was estimated at the mean value of the counterpart interacting variable.

* $p < .05$.

** $p < .01$.

*** $p < .001$.