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Association of Area Deprivation Index and hypertension, diabetes, dyslipidemia, and Obesity: A Cross-Sectional Study of the HABS-HD Cohort

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Abstract

Objective: This study aims to investigate the association between neighborhood deprivation and the prevalence of major cardiovascular disease (CVD) risk factors (hypertension, diabetes, dyslipidemia, and obesity) in a Mexican American (MA) population compared to NonHispanic Whites (NHW). **Method:** A cross-sectional analysis was conducted to include 1,867 subjects (971 MA and 896 NHW). Participants underwent a clinical interview, neuropsychological exam battery, functional examination, MRI of the head, amyloid PET scan, and blood draw for clinical and biomarker analysis. We use the Area Deprivation Index (ADI) Model to assign an ADI score to participants based on their neighborhoods. Descriptive, Cochran-Armitage test for trend, and odds ratio statistical analysis were applied. **Results:** Our results suggest that NHW had higher odds of having HTN, DM, and obesity in the most deprived neighborhoods, while MA showed no increased odds. The study also found that neighborhood deprivation contributed to diabetes in both MA and NHW and was associated with obesity in NHW. **Conclusions:** These findings highlighted the importance of addressing both individual and societal factors in efforts to reduce cardiovascular risk. Future research should explore the relationship between socio-economic status and cardiovascular risk in more detail to inform the development of targeted interventions.

Keywords

Mexican American, neighborhood socioeconomic status, cardiovascular risk factors, area deprivation index

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Introduction

The Centers for Disease Control and Prevention (2018) reported that 700,000 people died in 2020 from heart disease, and according to the American Heart Association (2019), by 2035, close to 50% of the US population will have some form of cardiovascular disease (CVD). Research has shown that socioeconomic status (SES) has a measurable and important impact on CVD prevalence and outcomes (Schultz et al., 2018), with risk factors associated with CVD more prevalent in individuals from low socioeconomic groups (National Center of Health Statistics, 2012). While a considerable amount of research has examined the biological factors and health behaviors that contribute to CVD (Shiffman et al., 2020; Tran et al., 2021), there is a need for more research focused on the association between social determinants of health, such as neighborhood socioeconomic deprivation, with CVD risk factors and biological markers of CVD risk. Galobardes et al. (2006) define neighborhood socioeconomic deprivation as "the relatively low physical (e.g. houses for sale, graffiti), social (e.g. unemployment, non-voter), and economical position (e.g. income, education level) of a neighborhood." Hypertension (HTN), the most common risk factor for CVD (Fuchs & Welton, 2020) has been associated with neighborhood deprivation (Xu et al., 2022). Other major CVD risk factors such as diabetes mellitus (DM), obesity, and dyslipidemia, have been also associated with neighborhood deprivation (Hu et al., 2021; Sheets et al., 2020;

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Shohaimi et al., 2014). The pathway between neighborhood deprivation and CVD is poorly understood. Several mechanisms have been studied: reduced access to behaviors that promote healthy lifestyles, and environmental conditions that do not facilitate physical activity (Calling et al., 2016); food insecurity, defined as the inability to access nutritious food, and relying in inexpensive high-calorie foods (Laraia, 2013); and environmental chronic stress as a result of high crime rate, abandoned buildings, physical incivilities, and litter (Augustin et al., 2008).

The Pew Research Center (2019) reported that an estimated 36.6 million Hispanics of Mexican origin live in the US, 26% in Texas, and about 20% of them live in poverty (Noe-Bustamante et al., 2019). Despite the size and growth of the Mexican American (MA) population, studies of the association between neighborhood deprivation and cardiovascular risk factors are scarce (Gallo et al., 2022; Savin et al., 2022).

The purpose of this study was to investigate if neighborhood deprivation, measured by the area deprivation index (ADI) (Kind et al., 2018), is associated with a higher prevalence of HTN, DM, dyslipidemia, and obesity. Also, we sought to evaluate if individuals living in a deprived neighborhood have increased odds of presenting with cardiovascular risk factors (CVRF). It is hypothesized that those living in neighborhoods with greater area deprivation index will have a higher prevalence and higher odds of having HTN, DM, dyslipidemia, and obesity. We also hypothesized that the relationship between neighborhood deprivation and CVRF will be impacted by ethnicity.

Methods

Study Design and Setting

Since 2017, the Health and Aging Brain Study: Health Disparities (HABS-HD) has been recruited participants. The HABS-HD study, previously known as the HABLE study, is a longitudinal community-based study. Subjects included for participation had an age of 50 and above and self-identified as Mexican American (MA), non-Hispanic White (NHW), or African American (AA). After signing a written consent form, HABS-HD participants undergo a clinical interview, neuropsychological exam battery, functional examination, MRI of the head, amyloid PET scan, and fasting blood draw for clinical and biomarker analysis. A comprehensive description of the HABS-HD study, including recruitment, inclusion-exclusion criteria, methodology, etc., has been published elsewhere (O'Bryant et al., 2021). The current study is a cross-sectional analysis of data from the HABS-HD study.

All HABS-HD data is available to the scientific community through the UNTHSC Institute for Translational Research (ITR) website at https://apps.unthsc.edu/itr/.

Study Population

From March 2017 until June 2022, 2,384 subjects were enrolled in the study. One thousand and forty-five participants self-identified as MA, 295 as AA, and 1,044 as NHW. One hundred and forty-six AA did not have enough information to obtain the ADI and/or a CVD diagnosis. Due to sample size limitations on statistical power, we excluded AA from the analysis. Of the remaining 2,089 participants, 137 were excluded due to lack of demographic information along with an additional 85 participants that did not have information to make an accurate diagnosis of HTN, DM, dyslipidemia, and obesity. All participants included in the final analysis (971 MA and 896 NHW) met the following criteria: (1) self-reported ethnicity as Mexican American or Non-Hispanic White, (2) have complete data to determine ADI, (3) have all data required for a diagnosis of HTN, DM, dyslipidemia, and obesity, (4) have complete data for all covariates (i.e., age, sex, education).

Area Deprivation Index

The ADI is a composite measure of neighborhood socioeconomic disadvantage (Kind et al., 2018) that uses 17 census variables including education, employment, family income, poverty level, occupation, unemployment rate, rate of home ownership, and access to telephones and vehicles to determine the level of disadvantage. The ADI allows for comparisons at the census-block group level and is publicly available at https://www.neigborhoodatlas.medicine.wisc.edu/. For analysis, we used the national ADI percentile ranking, with scores from 1 to 100. A score/ranking of 1 shows the lowest level of neighborhood disadvantage (least deprived), and a ranking/score of 100 is the highest level of neighborhood disadvantage (most deprived).

Cardiovascular Risk Factors

Hypertension. Hypertension was classified by self-reported medical history, use of blood pressure lowering drugs, and/or an average of two blood pressure measurements $\geq$140/$\geq$90 mm Hg per the American Heart Association Guidelines.

Diabetes Mellitus Type 2. Diabetes was classified via self-reported medical diagnosis, current use of insulin or oral hypoglycemic agents, and/or HbA1c $\geq$6.5% per the American Diabetes Association guidelines.

Dyslipidemia. Participants were classified as having dyslipidemia if they had a medical diagnosis of high cholesterol and/or triglycerides, use of cholesterol-lowering drugs, and/or total cholesterol $>$200 mg/dL (National Heart, Lung and Blood Institute), and triglycerides $>$150 mg/dL (National Heart, Lung, and Blood Institute).

Table 1. Baseline Characteristics.

	Total	MA	NHW		
	N = 1,867	*N* = 971	*N* = 896		
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	T [95% CI]	*p*
Age	65.90 (12.53)	63.37 (7.96)	68.64 (8.72)	13.65 [4.51, 6.02]	<.0001
Education	12.53 (4.80)	9.69 (4.58)	15.61 (2.64)	33.84 [5.57, 6.26]	<.0001
	N (%)	*N* (%)	*N* (%)	X^2 [95% CI]	*p*
Sex (female)	1,138 (61)	636 (65.5)	502 (56)	17.65 [5.06, 13.88]	<.0001
HTN (yes)	1,148 (61.5)	631 (65)	517 (57.7)	10.48 [2.88, 11.68]	.001
DM (yes)	460 (24.6)	347 (35.7)	113 (12.6)	133.93 [19.33, 26.76]	<.0001
Dyslipidemia (yes)	1,232 (66)	655 (67.5)	577 (64.4)	1.99 [−1.19, 7.39]	.150
Obesity (yes)	818 (43.8)	478 (49.2)	340 (37.9)	24.16 [6.8, 15.72]	<.0001
ADI					
Percentile 1 (least deprived)	279 (14.9)	73 (7.5)	206 (23)	88.05 [12.29, 18.73]	<.0001
Percentile 2	472 (25.3)	121 (12.5)	351 (39.2)	175.62 [22.84, 30.46]	<.0001
Percentile 3	448 (24)	219 (22.6)	229 (25.6)	2.29 [−0.87, 6.88]	.120
Percentile 4 (most deprived)	668 (35.8)	558 (57.5)	110 (12.3)	413.96 [41.3, 48.86]	<.0001

Note. MA = Mexican American; NHW = non-Hispanic Whites; *SD* = standard deviation.

Obesity. To calculate obesity height (in inches) and weight (in pounds) were measured. Following the World Health Organization guidelines, participants with a BMI of 30 or higher were classified as obese.

Covariates. Demographic information (age, sex, and total years of education) were self-reported during the interview and entered as covariates.

Statistical Analysis. Data were analyzed with SPSS version 27 for Windows (SPSS INC., Chicago, IL). Chi-squared was used to assess differences in categorical variables and *t*-test for differences in the continuous variables. We also analyzed the prevalence of CVRF by ADI quartiles. The Cochran-Armitage test for trend allows for testing the difference between percentages or proportions with within-subject design for two or more levels. This test was used to evaluate trends in the association of HTN, DM, dyslipidemia, and obesity (0 = no, 1 = yes), and ADI quartiles 1 to 4 (1 = least deprived neighborhood, 4 = most deprived neighborhood). Finally, binary logistic regression was used to find the odds ratio of having the CVRF among participants in ADI quartiles 1 and 4. All the analyses were split by ethnicity while controlling for age, sex, and education. The one sided .05 level was used to determine statistical significance.

Results

Demographics

Table 1 presents the characteristics of the sample. The total sample of 1,867 participants had a mean age of 65.90 (*SD* 12.53); 61% of participants were female and with a mean of 12.53 (*SD* 4.80) years of education. When compared to Non-Hispanic Whites, MA were significantly younger and had fewer years of education ($p \leq .05$). MA had a significantly higher prevalence of HTN, DM, and obesity. Only 12.3% of Non-Hispanic Whites lived in the most deprived neighborhoods (percentile 4), while 57.5% of Mexican Americans lived in the percentile 4 ranking areas ($p \leq .05$).

Linear Association of Cardiovascular Risk Factors With ADI Quartiles

The Cochran-Armitage test was used to assess if the probability of having HTN, DM, dyslipidemia, or obesity increases as the ADI quartile increases. Table 2 shows that for MA, a significant linear increase from 30.1% to 41.8% was seen for DM. For NHW, a significant linear increase by ADI quartiles was observed for HTN (from 50% to 68.2%), DM (from 6.8% to 20%), and obesity (from 24.8% to 50%) (Table 3).

Association of Least and Most Deprived Neighborhoods With CVRF

As seen in Table 4, when compared with those in ADI quartile 1 (least deprived), MA living in the most deprived neighborhoods (quartile 4), showed no significant difference in the odds of having HTN, DM, dyslipidemia, or obesity when compared with those living in the least deprived neighborhoods. NHW participants living in the most deprived neighborhoods were 2.14

Table 2. Cochran-Armitage Test for Trend—Mexican American.

	Percentile 1	Percentile 2	Percentile 3	Percentile 4	
	N (%)	*N* (%)	*N* (%)	*N* (%)	*p* Value for trend
Hypertension					
Yes	45 (61.6)	79 (65.3)	141 (64.4)	366 (65.6)	.921
No	28 (38.4)	42 (34.7)	78 (35.6)	192 (34.4)	
Diabetes					
Yes	22 (30.1)	24 (19.8)	68 (31.1)	233 (41.8)	<.0001
No	51 (69.9)	97 (80.2)	141 (68.9)	325 (58.2)	
Dyslipidemia					
Yes	52 (71.2)	83 (68.6)	138 (63)	382 (68.5)	.421
No	21 (28.8)	38 (31.4)	81 (37)	176 (31.5)	
Obesity					
Yes	33 (45.2)	56 (46.3)	100 (45.7)	289 (51.8)	.320
No	40 (54.8)	65 (53.7)	119 (54.3)	269 (48.2)	

Table 3. Cochran-Armitage Test for Trend—Non-Hispanic White.

	Percentile 1	Percentile 2	Percentile 3	Percentile 4	
	N (%)	*N* (%)	*N* (%)	*N* (%)	*p* Value for trend
Hypertension					
Yes	103 (50)	200 (57)	139 (60.7)	75 (68.2)	.001
No	103 (50)	151 (43)	90 (39.3)	35 (31.8)	
Diabetes					
Yes	14 (6.8)	39 (11.1)	38 (16.6)	22 (20)	.001
No	192 (93.2)	312 (88.9)	191 (83.4)	88 (80)	
Dyslipidemia					
Yes	118 (57.3)	232 (66.1)	153 (66.8)	74 (67.3)	.113
No	88 (42.7)	119 (33.9)	76 (33.2)	36 (32.7)	
Obesity					
Yes	51 (24.8)	136 (38.7)	98 (42.8)	55 (50)	<.0001
No	155 (75.2)	215 (61.3)	131 (57.2)	55 (50)	

times more likely to have HTN (*OR*=2.14, 95% CI [1.31, 3.48]), 3.42 times more likely to have a DM diagnosis (*OR*=3.42; 95% CI [1.67, 7.01]), and 3.03 times more likely of being obese (*OR*=3.03, 95% CI [1.86, 4.95]) than those leaving in the least deprived neighborhoods. There was no significant difference in the odds of having dyslipidemia between non-Hispanic Whites living in the ADI quartile 1 when compared to those living in the ADI quartile 4.

Discussion

The present study examines whether the ADI is associated with HTN, DM, dyslipidemia, and obesity in MA and NHW enrolled in the HABS-HD study. Among middle age and older adults in our cohort, MA showed an increased probability of having DM as the ADI quartile increased. In NHW, the test for trend was significant for HTN, DM, and obesity. We also found that the odds of having HTN, DM, and obesity were higher for NHW living in the most deprived neighborhoods, while their MA counterparts showed no increased odds.

Despite living in similarly deprived neighborhoods (quartile 4), higher associations were found between neighborhood deprivation and CVRF in NHW than in MA. An explanation for these findings may be that cultural, behavioral, and socioeconomic factors associated with cardiovascular risk may have a different impact on Hispanics. Morales et al. (2002) did an extensive review and found that tobacco use, alcohol consumption, and diet have a greater impact on NHW health outcomes when compared to Hispanics. Dubowitz et al. (2008) stated that there is a possibility that MA are less susceptible to the effects of environmental factors because of the strong cultural influence on their diet. Becares et al. (2012), in a systematic review of the association of ethnic density (areas with a higher concentration of people from their own racial/ethnic group) with health, mortality, and health behaviors reported a protective effect of Hispanic ethnic density, especially for health behaviors. However, none of the studies in the review adjusted for area deprivation.

Studies in NHW cohorts have reported that living in more deprived neighborhoods is associated with higher

Table 4. Odds Ratio. ADI Percentile 1 Versus Percentile 4.

	Mexican American		Non-Hispanic White	
	OR [95% CI]	*p*	*OR* [95% CI]	*p*
Hypertension	1.18 [0.71, 1.96]	.501	2.14 [1.31, 3.48]	.002
Diabetes	1.66 [0.98, 2.81]	.059	3.42 [1.67, 7.01]	.0007
Dyslipidemia	0.87 [0.51, 1.5]	.483	1.53 [0.94, 2.48]	.080
Obesity	1.3 [0.79, 2.12]	.291	3.03 [1.86, 4.95]	<.0001

prevalence and increased odds of having HTN (Keita et al., 2014; Xu et al., 2022) which is consistent with our findings. Contrary to our results, a study using data from the Multi-Ethnic Study of Atherosclerosis (MESA) (Mujahid et al., 2011) showed that Hispanics living in more stressful neighborhoods have a higher prevalence of HTN. One explanation may be the different Hispanic cohort background, 63.6% of Hispanics in the MESA study were foreign-born, and of those, 67.8% reported a place of origin in the Caribbean, while 100% of our Hispanic cohort is of Mexican origin. Recent research reporting results from 3,000 subjects (92.9% of Mexican origin) from the Hispanic Community Health Study/ Study of Latinos and the SOL CASAS ancillary study (Savin et al., 2022), reported that socioeconomic deprivation was cross-sectionally and longitudinally associated with greater systolic blood pressure and the incidence of HTN. The difference in the findings may be at least in part due to the use of different methodologies to define HTN (e.g., using systolic blood pressure as a continuous variable, instead of HTN as a dichotomous variable).

Our findings suggest that neighborhood deprivation contributes to DM in both MA and NHW. Similar results were found in Sweden (Mezuk et al., 2013) and in a multiethnic population in the United States (Laraia et al., 2012). The lack of healthy foods, lack of recreational infrastructure, and air pollution, have been named as mechanisms that contribute to this link (Astell-Burt et al., 2014; Bilal et al., 2018; Morland & Evenson, 2009).

In a meta-analysis covering over 1 million subjects in high-income countries, Mohammed et al. (2019), concluded that living in low socioeconomic status neighborhoods was associated with higher odds of being overweight and obese. They consider the high availability of high-energy and junk food as the main contributing factor. For Hispanics, place of birth has been found to be an important factor when considering the link between segregation, neighborhood poverty level, and the risk of obesity. Phuong Do and Frank (2020) found no association between residing in poor neighborhoods and the risk of obesity in Hispanic immigrants, while the association exists in native Hispanics. Wen and Maloney (2011) also found that in Hispanics, there was a difference in obesity risk among US-born Hispanics and immigrants when compared to NHW, a difference that was not explained by neighborhood context. In our analyses, we did not consider nativity which may explain the lack of association between neighborhood socioeconomic status and obesity in our MA cohort. Future analyses with nativity variables are needed to clarify how neighborhood deprivation is related to obesity.

Contrary to other studies, we did not find a relationship between neighborhood deprivation and cholesterol. Jenkins and Ofstedal (2014) found that this association is driven by gender. Other authors reported similar results about sex differences in the association of lipid levels and socio-economic status (Shohaimi et al., 2014). Future analyses stratified by sex may help to clarify the differences.

Our study is subject to a number of limitations. The data are cross-sectional and causal inferences cannot be drawn from the results. Due to our Hispanic cohort being 100% Mexican Americans, the results may not be generalizable to other Hispanic populations. Factors such as duration of residence and changes in living environment along with other variables such as smoking status, physical activity, diet, chronic kidney disease, and medication use may have an impact and will need to be addressed in future research. Other factors like the different stress coping mechanisms, and family and religious support systems, may vary by ethnicity and need to be consider in future research. Even given these limitations, the current research shows the importance of ethnicity in evaluating the link between living in a deprived neighborhood and cardiovascular health.

Conclusion

The area deprivation index is associated with cardiovascular risk factors. Where we live matters. This study adds to the research that cardiovascular risk factors are not only a product of individual variables, but are related to social determinants of health. Analyzing these social determinants of health within and between ethnicity is an important contribution to the literature in the topic. Cardiovascular risk is attributed to modifiable factors with tremendous implications for intervention approaches tailored to individual and neighborhood determinants of health. Future studies of the difference in cardiovascular risk factors across socioeconomic levels are warranted.

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Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: RV, AS, JH, declare that there is no conflict of interest. LJ has a financial interest in CX Precision Medicine, Inc. SO has multiple patents on precision medicine for neurodegenerative diseases and is the scientific founder of CX Precision Medicine, Inc.

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Ethics Statement

The study has been approved by the North Texas Institutional Review Board (Prot. No. 2016-128).

Informed Consent

Written informed consent was obtained from each participant, and the study adhered to the guidelines outlined in the Declaration of Helsinki (World Medical Association, 2008).

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References

American Diabetes Association. *Understanding A1C. Diagnosis*. Retrieved May 4, 2023, from diabetes.org/diabetes/a1c/diagnosis

American Heart Association. (2017, November 30). *The facts about high blood pressure*. https://www.heart.org/en/health-topics/high-blood-pressure/the-facts-about-high-blood-pressure

American Heart Association. (2019, January 31). *Cardiovascular diseases affect nearly half of American adults, statistics show*. https://www.heart.org/en/news/2019/01/31/cardiovascular-diseases-affect-nearly-half-of-american-adults-statistics-show

Astell-Burt, T., Feng, X., & Kolt, G. S. (2014). Is neighborhood green space associated with a lower risk of type 2 diabetes? Evidence from 267,072 Australians. *Diabetes Care*, *37*, 197–201. https://doi.org/10.2337/dc13-1325

Augustin, T., Glass, T. A., James, B. D., & Schwartz, B. S. (2008). Neighborhood psychosocial hazards and cardiovascular disease: The Baltimore memory study. *American Journal of Public Health*, *98*(9), 1664–1670. https://doi.org/10.2105/AJPH.2007.125138

Becares, L., Shaw, R., Nazroo, J., Stafford, M., Albor, C., Atkin, K., Kathleen, K., Wilkinson, R., & Pickett, K. (2012). Ethnic density effects on physical morbidity, mortality, and health behaviors: A systematic review of the literature. *American Journal of Public Health*, *102*(12), Article e33–e66. https://doi.org/10.2105/AJPH.2012.300832

Bilal, U., Auchincloss, A. H., & Diez-Roux, A. V. (2018). Neighborhood environments and diabetes risk and control. *Current Diabetes Reports*, *18*(9), Article 62. https://doi.org/10.1007/s11892-018-1032-2

Calling, S., Li, X., Kawakami, N., Hamano, T., & Sundquist, K. (2016). Impact of neighborhood resources on cardiovascular disease: A nationwide six-year follow up. *BMC Public Health, 16*, Article 634. https://doi.org/10.1186/s12889-016-3293-5

Centers for Disease Control and Prevention. (2018). *Heart disease facts*. Retrieved October 19, 2022, from https://www.cdc.gov/heartdisease/facts.htm

Dubowitz, T., Heron, M., Bird, C. E., Lurie, N., Finch, B. K., Basurto-Davila, R., Hale, L., & Escarce, J. J. (2008). Neighborhood socioeconomic status and fruit and vegetable intake among Whites, Blacks, and Mexican Americans in the United States. *The American Journal of Clinical Nutrition*, *87*(6), 1883–1891. https://doi.org/10.1093/ajcn/87.6.1883

Fuchs, F. D., & Welton, P. K. (2020). High blood pressure and cardiovascular disease. *Hypertension*, *75*(2), 285–292. https://doi.org/10.1161/HYPERTENSIONAHA.119.14240

Gallo, L. C., Savin, K. L., Jankowska, M. M., Roesch, S. C., Sallis, J. F., Sotres-Alvarez, D., Talavera, G. A., Perreira, K. M., Isasi, C. R., Penedo, F. J., Llabre, M. M., Estrella, M. L., Chambers, E. C., Daviglus, M. L., Brown, S. C., & Carlson, J. A. (2022). Neighborhood environment and metabolic risk in Hispanics/Latinos from the Hispanic community health study/study of Latinos. *American Journal of Preventive Medicine*, *63*(2), 195–203. https://doi.org/10.1016/j.amepre.2022.01.025

Galobardes, B., Shaw, M., Lawlor, D. A., Lynch, J. W., & Davey, S. G. (2006). Indications of socioeconomic position part 1. *Journal of Epidemiology and Community Health*, *60*(1), 7–12. https://doi.org/10.136/jech.2004.023531

Hu, M. D., Lawrence, K. G., Bodkin, M. R., Kwok, R. K., Engel, L. S., & Sandler, D. P. (2021). Neighborhood deprivation, obesity, and diabetes in residents of the US gulf coast. *American Journal of Epidemiology*, *190*(2), 295–304. https://doi.org/10.1093/aje/kwaa206

Institute for Translational Research. https://apps.unthsc.edu/itr/

Jenkins, K. R., & Ofstedal, M. B. (2014). The association between socioeconomic status and cardiovascular risk factors among middle-aged and older men and women. *Women Health*, *54*(1), 15–34. https://doi.org/10.1080/03630242.2013.858098

Keita, A. D., Judd, S. E., Howard, V. J., Carson, A. P., Ard, J. D., & Fernandez, J. R. (2014). Associations of neighborhood area level deprivation with the metabolic syndrome and inflammation among middle-age adults. *BMC Public Health*, *14*, Article 1319. https://doi.org/10.1186/1471-2458-14-131927

Kind, A. J. H., & Buckingham, W. R. (2018). Making neighborhood-disadvantage metrics accessible—The neighborhood Atlas. *New England Journal of Medicine*, *378*(26), 2456–2458. http://doi.org/10.1056/NEJMp1802313

Laraia, B. A. (2013). Food insecurity and chronic disease. *Advances in Nutrition*, *4*(2), 203–212. https://doi.org/10.3945/an.112.003277

Laraia, B. A., Carter, A. J., Warton, E. M., Schillinger, D., Moffet, H. H., & Adler, N. (2012). Place matters: Neighborhood deprivation and cardiometabolic risk factors in the diabetes study of Northern California (DISTANCE). *Social Science & Medicine*, *74*(7), 1082–1090. https://doi.org/10.1016/j.socscimed.2011.11.036

Mezuk, B., Chaikiat, A., Li, X., Sunquist, J., Kendler, K., & Sunquist, K. (2013). Depression, neighborhood deprivation and risk of diabetes type 2. *Health Place*, *23*, 63–69. https://doi.org/10.1016/j.healthplace.2013.05.004

Mohammed, S. H., Habtewold, T. D., Birhanu, M. M., Sissay, T. A., Tegegne, B. S., Abuzerr, S., & Esmaillzadeh, A. (2019). Neighborhood socioeconomic status and overweight/obesity: A systematic review and meta-analysis of epidemiological studies. *BMJ Open*, *9*, Article e028238. https://doi.org/10.1136/bmjopen-2018-028238

Morales, L., Lara, M., Kington, R. S., Valdez, R. O., & Escarce, J. J. (2002). Socioeconomic, cultural, and behavioral factors affecting Hispanics health outcomes. *Journal for Health Care for the Poor and Underserved*, *13*(4), 477–503. http://doi.org/10.1177/104920802237532

Morland, K. B., & Evenson, K. R. (2009). Obesity prevalence and the local food environment. *Health Place*, *15*(2), 491–495. https://doi.org/10.1016/j.healthplace.2008.09.004

Mujahid, M. S., Diex Roux, A. V., Cooper, R. C., Shea, S., & Williams, D. R. (2011). Neighborhood stressors and race/ethnic differences in hypertension prevalence (the multi-ethnic study of atherosclerosis). *American Journal of Hypertension*, *24*(2), 187–193. https://doi.org/10.1038/ajh.2010.200

National Center for Health Statistics. (2012). *Health, United States, 2011: With special feature on socioeconomic status and health*. https://www.cdc.gov/nchs/data/hus/hus11.pdf

National Heart, Lung, and Blood Institute. *Blood cholesterol*. Retrieved May 4, 2023, from https://www.nhlbi.gov/health-topics/high-cholesterol

National Heart, Lung, and Blood Institute. *High blood triglycerides*. Retrieved May 4, 2023, from https://www.nhlbi.gov/health/high-blood-triglycerides#:~:text=Triglycerides%20levels%20usually%20fall%20into,200%20and%20499%20mg%2FdL

Noe-Bustamante, L., Flores, A., & Shah, S. (2019, September 16). *Facts on Hispanics of Mexican origin in the United States, 2017*. Pew Research Center. https://www.pewresearch.org/hispanic/fact-sheet/u-s-hispanics-facts-on-mexican-origin-latinos/

O'Bryant, S. E., Johnson, L. A., Barber, R. C., Braskie, M. N., Christian, B., Hall, J., Hazra, N., King, K., Kothapalli, D., Large, S., Mason, D., Matsiyevskiy, E., McColl, R., Nandy, R., Palmer, R., Melissa, P., Phillips, N., Rissman, R. A., & Shi, Y. . . . HABLE Study Team. (2021). The Health & Aging among Latino Elders (HABLE) study methods and participant characteristics. *Alzheimer's and Dementia*, *13*, Article e12202. https://doi.org/10.1002/dad2.12202

Phuong Do, D., & Frank, R. (2020). The diverging impacts of segregation on obesity risk by nativity and neighborhood poverty among Hispanic Americans. *Journal of Racial and Ethnic Health Disparities*, *7*, 1214–1224. https://doi.org/10.1007/s40615-020-00746-2

Savin, K. L., Roesch, S. C., Oren, E., Carlson, J. A., Allison, M. A., Sotres-Alvarez, D., Sallis, J. F., Jankowska, M. M., Talavera, G. A., Rodriguez, T. M., Chambers, E. C., Daviglus, M., Perreira, K. M., Llabre, M. M., & Gallo, L. C. (2022). Social and built neighborhoods environments and blood pressure 6 years later: Results from the Hispanic community health study/study of Latinos and SOL CASAS ancillary study. *Social Science & Medicine*, *29*, Article 114496. https://doi.org/10.1016/j.socscimed.2021.114496

Schultz, M. W., Kelli, H. M., Lisko, J. C., Varghese, T., Shen, J., Sandesara, P., Quyyumi, A. A., Taylor, H. A., Gulati, M., Harold, J. G., Mieres, J. H., Ferdinand, K. C., Mensah, H. A., & Sperling, L. S. (2018). Socioeconomic status and cardiovascular outcomes: Challenges and interventions. *Circulation*, *137*(20), 2166–2178. https://doi.org/10.1161/CIRCULATIONAHA.117.029652

Sheets, L. R., Henderson Kelley, L. E., Scheitler-Ring, K., Petroski, G. F., Barnett, Y., Barnett, C., Kind, A. J. H., & Parker, J. C. (2020). An index of geospatial disadvantage predicts obesity and unmeasured body weight. *Preventive Medicine Reports*, *18*, Article 101067. https://doi.org/10.1016/j.pmedr.2020.101067

Shiffman, D., Louie, J. Z., Devlin, J. J., Rowland, C. M., & Mora, S. (2020). Concordance of cardiovascular risk factors and behaviors in a multiethnic US nationwide cohort of married couples and domestic partners. *JAMA Network Open*, *3*(10), Article e2022119. https://doi.org/10.1001/jamanetworkopen.2020.22119

Shohaimi, S., Boekholdt, M. S., Luben, R., Wareham, N. J., & Khaw, K. T. (2014). Distribution of lipid parameters according to different socio-economic indicators- the EPIC-Norfolk prospective population study. *BMC Public Health*, *14*, Article 782. http://doi.org/10.186/1471-2458-14-782

Tran, D.-M. T., Lekhak, N., Gutierrez, K., & Moonie, S. (2021). Risk factors associated with cardiovascular disease among adult Nevadans. *PLoS One*, *16*(2), Article e0247105. https://doi.org/10.1371/journal.pone.0247105

Wen, M., & Maloney, T. N. (2011). Latino residential isolation and risk of obesity in Utah: The role of neighborhood socioeconomic, built-environment, and subcultural context. *Journal of Immigrant and Minority Health*, *13*(6), 1134–1141. https://doi.org/10.1007/s10903-0-11-9439-8

World Health Organization. *Obesity*. Retrieved September 28, 2022, from https://www.who.int/health-topics/obesity#tab=tab_1

Xu, J., Lawrence, K. G., O'Brien, K. M., Jackson, C. L., & Sandler, D. P. (2022). Association between neighborhood deprivation and hypertension in a US-wide cohort. *Journal of Epidemiology and Community Health*, *76*, 268–273. https://doi.org/10.1136/jech-2021-216445