DASH diet and prevalent metabolic syndrome in the Hispanic Community Health Study/Study of Latinos

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https://doi.org/10.1016/j.pmedr.2019.100950
Received 25 September 2018; Received in revised form 25 June 2019; Accepted 12 July 2019
Available online 16 July 2019
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ARTICLE INFO

Keywords:
Metabolic syndrome
Hispanics/Latinos
Diet
DASH
Diet quality scores

ABSTRACT

The Dietary Approaches to Stop Hypertension (DASH) diet is recommended for lowering blood pressure and preventing cardiovascular disease (CVD), but little data exist on these associations in US Hispanics/Latinos. We sought to assess associations between DASH score and prevalence of metabolic syndrome (MetS) and its components in diverse Hispanics/Latinos. We studied 10,741 adults aged 18–74 in the multicenter Hispanic Community Health Study/Study of Latinos. Dietary intake was measured using two 24-hour recalls, and MetS defined per the 2009 harmonized guidelines. We assessed cross-sectional associations of DASH score and MetS (and its dichotomized components) using survey logistic regression, and DASH and MetS continuous components using linear regression. We also stratified these models by Hispanic/Latino heritage group to explore heritage-specific associations. We found no associations between DASH and MetS prevalence. DASH was inversely associated with both measures of blood pressure (p < 0.01 for systolic and p < 0.001 for diastolic) in the overall cohort. DASH was also inversely associated with diastolic blood pressure in the Mexican (p < 0.05), Central American (p < 0.05), and South American (p < 0.01) groups; triglycerides (p < 0.05) in the Central American group; fasting glucose overall (p < 0.01) and in the Mexican group (p < 0.01); and waist circumference overall (p < 0.05) and in the South American group (p < 0.01). DASH was positively associated with HDL-cholesterol (p < 0.01) in the Central American group. DASH may better capture diet-MetS associations in Hispanic/Latino subpopulations such as Central/South Americans; this study also adds evidence that Hispanics/Latinos should be analyzed by heritage. Further research, and/or culturally tailored DASH measures will help further explain between-heritage differences.
1. Introduction

National data indicate that cardiovascular disease (CVD) is one of the leading causes of death among US Hispanics/Latinos driven in part by prevalent high blood cholesterol, high blood pressure, and overweight/obesity (Mozaffarian et al., 2015). This may be partially due to differential dietary patterns among Mexican Americans and other Hispanic/Latino heritage groups compared to non-Hispanic whites and African Americans (Mozaffarian et al., 2015; Angell et al., 2014; Cogswell et al., 2012). Data from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) demonstrate that behavioral CVD risk factors (including various dietary factors (Siega-Riz et al., 2014)) in diverse Hispanic/Latino groups can vary substantially from those in Hispanics/Latinos of Mexican heritage. This may be problematic for interpreting clinical research, as studies of Hispanics/Latinos frequently consider those of Mexican heritage representative of all US Hispanics/Latinos (Daviglus et al., 2012). The heterogeneity of dietary factors and CVD risk across Hispanic/Latino groups suggests a need for heritage-specific examinations of different dietary measures and their associations with cardiovascular risks. This will facilitate the ultimate goal of preventing cardiovascular morbidity and mortality in the US Hispanic/Latino population and its genetically, culturally, and behaviorally diverse heritage subgroups.

Some studies examined associations between diet and cardiovascular risk in specific Hispanic/Latino heritage groups (e.g., Puerto Ricans (Altieri et al., 2013; Mattei et al., 2013) and Cuban Americans (Huffman et al., 2012) among others). A study using data from HCHS/SOL showed that individuals of Mexican and Dominican heritage had the lowest prevalence of favorable CVD risk profiles compared to those of Cuban, Puerto Rican, and Central and South American heritages (Kershaw et al., 2016). Another study from HCHS/SOL also found associations between DASH diet and insulin resistance (Corsino et al., 2017). Mattei et al. examined associations between overall dietary quality (as measured using the Alternative Healthy Eating Index (AHEI)) and cardiometabolic risk factors and metabolic syndrome (MetS), and found different associations in the different Hispanic/Latino heritage groups represented in HCHS/SOL (Mattei et al., 2016). Studies of additional, overall nutrition indices in this population could help identify dietary components effective in reducing MetS and therefore CVD risk specific to individual Hispanic/Latino heritage groups, facilitating the development and uptake of tailored dietary interventions among these populations.

One such index is the Dietary Approaches to Stop Hypertension (DASH) diet, originally developed to control or prevent hypertension (Lin et al., 2007; Conlin et al., 2000). Numerous prior studies found associations between DASH diet and metabolic syndrome or one or more of its components (Aljefree and Ahmed, 2015; Azadbakht et al., 2005; Choi and Choi-Kwon, 2015; Nazare et al., 2013; Pimenta et al., 2015; Rankins et al., 2007; Root and Dawson, 2013; Saneii et al., 2015). However, few studies examined DASH diet among diverse Hispanics/Latinos in connection with metabolic syndrome or its components (beyond blood pressure) (Corsino et al., 2012; Harmon et al., 2015; Otto et al., 2015; Staffileno et al., 2013). Furthermore, prior studies identified distinct associations between DASH and cardiometabolic outcomes distinct from other diet scores (e.g., metabolically obese/normal weight (Park et al., 2017) and death from heart failure (Levitan et al., 2013)). These differences may reflect dietary elements emphasized by DASH score that are also particularly relevant for cardiometabolic health. Thus, a study of DASH and cardiometabolic outcomes and risk factors in diverse Hispanic/Latino groups may provide insights into heritage-specific drivers of MetS and cardiometabolic risk in the diverse Hispanic/Latino population. Our objective was to identify differences in associations between DASH diet and cardiometabolic outcomes between specific Hispanic/Latino groups, including which groups had the strongest DASH-MetS associations, as a first step towards identifying culture-specific dietary components that can reduce cardiometabolic disease risk and mortality in these populations.

2. Methods

2.1. Study population

HCHS/SOL is a prospective, community-based cohort of 16,415 participants who self-identified as Hispanic/Latino, were aged 18–74 at recruitment, and lived in randomly selected households in the areas of four US field centers (Chicago, IL; Miami, FL; Bronx, NY; and San Diego, CA). The current study used data from the HCHS/SOL baseline examinations, which were conducted from 2008 to 2011. Participants were recruited using a stratified, two-stage area probability sample of addresses in each field center. Complete details of this method were previously reported (Sorlie et al., 2010). Eligibility criteria were residence at that address, able to attend a clinic visit for data collection, and no plans to move within six months. All participants provided written informed consent. Institutional review boards for each field center and reading center, the coordinating center, and the National Heart, Lung, and Blood Institute all approved this study. The study was registered at clinicaltrials.gov as NCT02060344. In total, the HCHS/SOL sample size is 16,415 individuals. For this analysis we excluded individuals with missing data on DASH score or MetS (n = 258); triglycerides, HDL, blood pressure, and waist circumference (n = 193); lipid-lowering medication use (n = 329); missing depression symptom (n = 247); and other missing covariates (n = 279). We further excluded individuals with diabetes (n = 3082), self-reported CVD (n = 954), or self-reported cancer (n = 332). These exclusions resulted in a final sample size of 10,741 individuals for analyses.

2.2. Data collection

Full details of the HCHS/SOL data collection methodology, including field center and laboratory procedures, were described previously (Sorlie et al., 2010). Briefly, participants visited a clinic at their field center, at which all clinical assessments and interviews were conducted by personnel (trained using a central protocol) in the participant’s preferred language. Data collection included questions on demographic (including Hispanic/Latino heritage) and socioeconomic (including highest achieved education and annual household income) characteristics, lifestyle and health behaviors (including whether they currently, ever, or never smoked), acculturation, medical history, and medication use. Acculturation measures included whether participants were born in the US, number of years living in the US if born elsewhere (0–10 vs. > 10 years for analysis), language preference (English vs. Spanish), and generational level (first vs. second or higher generation immigrant). Participants self-identified as one of eight Hispanic/Latino heritage groups: Mexican or Mexican descent, Cuban or Cuban descent, Puerto Rican or Puerto Rican descent, Dominican or Dominican descent, Central American or Central American descent, South American or South American descent, more than one heritage, or other. Due to small sample sizes, multiple and other heritage groups were combined for this analysis. Physical activity was assessed via the Global Physical Activity Questionnaire (GPAQ) (Bull et al., 2009; Hoos et al., 2012), and self-reported hours of activity and sedentary behavior were converted into their metabolic equivalents and categorized as low, moderate, or high. Height was measured to the nearest centimeter and weight to the nearest 0.1 kg; from these body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Standard cut-points for BMI categories were applied (underweight < 18.5, normal 18.5–≤ 25, overweight 25–< 30, and obese ≥ 30), and due to sample size constraints underweight and normal categories were combined. Waist circumference was measured at the horizontal line immediately above the uppermost lateral border of the right ilium using non-stretchable measuring tape. Blood pressure was measured by trained, certified research staff in triplicate using an automated OMRON HEM-
907 XL sphygmomanometer after a 5-minute rest, and averaged to yield the final measurement. Fasting blood samples were collected via venipuncture upon participant arrival and shipped to the central laboratory for analysis. A Roche Modular P Chemistry Analyzer was used to measure serum triglycerides, serum HDL cholesterol, and plasma glucose (Roche Diagnostics). Depressive symptoms were measured using the 10-item Center for Epidemiological Studies Depression Scale (CESD-10) as described previously (Wassertheil-Smoller et al., 2014). Anxiety symptoms were measured using the shortener Spielberger Trait Anxiety Scale (STAS), also as described previously (Wassertheil-Smoller et al., 2014).

2.3. Dietary assessment and DASH score calculation

Detailed procedures for dietary data collection have been described previously (Siega-Riz et al., 2014; Mattei et al., 2016; Mossavar-Rahmani et al., 2015). Briefly, study coordinators administered two 24-hour dietary recalls; one in person at the baseline visit and one either over the phone or in person between five and 30 days later (> 99% of the HCHS/SOL cohort had their second dietary recall within this window). Over 88% of the recalls were unannounced, and scheduled by staff with the goal of evenly distributing them throughout the days of the week. Recalls with energy intakes below the sex-specific first or > 99th percentiles, or that were deemed unreliable by the interviewer, were excluded. Intakes were analyzed using the Nutrition Data System for Research v. 11 (Nutrition Coordinating Center, University of Minnesota), which includes Hispanic/Latino foods. DASH score was calculated using the average intakes of both dietary recalls where available (94% of the HCHS/SOL cohort had data from both dietary recalls), based on the guidelines described in Karanja et al. (1999) and the components and standards for minimum and maximum scores from Günther et al. (Corsino et al., 2017; Gunther et al., 2009) to be consistent with a prior study of DASH in HCHS/SOL (Corsino et al., 2017).

The eight DASH components were scored according to intakes of total and whole grains, vegetables (excluding potatoes), fruits (including juice), dairy, red/processed meat, nuts/seeds/legumes, fats/oils, and sweets on a range of 0–10. The individual components were scored according to predefined cut-points (see Table 1), and added to yield an overall DASH score range of 0–80. Higher DASH scores indicate an overall healthier diet and higher component scores indicate higher consumption of grains, vegetables, fruit, dairy, and nuts/seeds/legumes and lower consumption of red/processed meat, fats/oils, and sweets.

2.4. MetS definition

This study used the same definition of MetS as prior HCHS/SOL studies (Heiss et al., 2014). Briefly, we defined metabolic syndrome as the presence of three or more of the following criteria: Abdominal obesity > 102 cm in men, > 88 cm in women; elevated blood pressure (≥ 130/85 mmHg) or use of antihypertension medications; high triglycerides (≥ 1.28 mmol/L (150 mg/dL)); low HDL cholesterol (< 1.03 mmol/L (40 mg/dL)) in men, < 1.28 mmol/L (50 mg/dL) in women; and impaired fasting glucose (≥ 5.8 mmol/L (100 mg/dL)) or use of antidiabetic medications.

2.5. Statistical analyses

We weighted reported estimates to adjust for sampling probability and nonresponse. The means of DASH score and its components were computed by Hispanic/Latino heritage and other characteristics. We divided continuous covariates into tertiles for presentation only and performed descriptive analyses of subject characteristics across heritage groups and DASH score across subject characteristics. We reported the proportions and 95% CIs for categorical variables and means and 95% CIs for continuous variables, comparing characteristics across Hispanic/Latino heritage groups using F-tests and χ²-tests respectively (Table 2). Two groups were excluded from calculation due to small sample size—Dominicans and five Cuban participants at the San Diego site (n = 1 and 5, respectively). Next we compared mean DASH score across participant characteristics in Table 3, all performed using F-tests. The associations between overall DASH score with dichotomous metabolic syndrome and each component by Hispanic/Latino heritage were examined using multivariable logistic regression and odds ratios (ORs) with 95% confidence intervals (CIs). We used linear regression analyses to examine associations of overall DASH score and each continuous MetS component by Hispanic/Latino heritage. Consistent with prior research (Mattei et al., 2016), we rescaled DASH score to 10-unit increments for all multivariable models and log-transformed triglycerides and HDL cholesterol to ensure an approximately normal distribution (and back-transformed the corresponding model coefficients for presentation). All linear and logistic regression models adjusted for age, sex, study site, nativity, smoking status, total alcoholic drinks per week, education, household income, marital status, depressive and anxiety symptoms, baseline visit season, physical activity, energy intake, and health insurance status. All models for the overall study population (i.e., non-stratified) were additionally adjusted for Hispanic/Latino heritage. Linear regression models were additionally adjusted for medication use in the appropriate analyses (e.g., lipid-lowering medication for the triglycerides and HDL analyses only). For all of the above multivariable models we ran additional sensitivity analyses comparing the effects of dropping nativity from the covariates of interest.

Next we assessed effect modification by including interaction terms between overall DASH score and Hispanic/Latino heritage for each outcome of interest. To facilitate comparisons with the prior study of MetS and AHEI in HCHS/SOL (Mattei et al., 2016), we conducted sensitivity analyses to examine the association between overall DASH

| Table 1 | Score calculation for each DASH component. |
|---|---|
| DASH component (servings/day) | Serving size or unit | Criteria for minimum score (0) | Criteria for maximum score (10) |
| 1a. Total grains | ⅛ cup or 1 slice or 1 oz. of ready-to-eat cereal | 0 servings/day | ≥ 6 servings/day |
| 1b. Whole grains | ⅛ cup or 1 slice or 1 oz. of ready-to-eat cereal | 0% daily servings | ≥ 50% daily servings |
| 2. Vegetables | 1 cup of raw leafy vegetables or ⅛ cup cooked or raw or 4 fluid oz. of juice | 0 servings/day | ≥ 4 servings/day |
| 3. Fruit | ⅛ cup or one medium piece or 4 fluid oz. of juice | 0 servings/day | ≥ 4 servings/day |
| 4a. Total dairy | 1 cup milk/yogurt or 1.5 oz. natural cheese or 2 oz. processed cheese | 0 servings/day | ≥ 2 servings/day |
| 4b. Low-fat dairy | 1 cup milk/yogurt or 1.5 oz. natural cheese or 2 oz. processed cheese | 0% daily servings | ≥ 75% daily servings |
| 5. Meat, poultry, fish, and eggs | All meats: 1 oz. Eggs: 1 egg | ≥ 4 servings/day | ≤ 2 servings/day |
| 6. Nuts/seeds/legumes | ⅛ oz. nuts or 1 TB nut butters | 0 servings/week | ≥ 4 servings/week |
| 7. Fats/oils | 1 TB butter/margarine/oil/shortening or 30 g salad dressing/ sour cream or 15 g mayonnaise or 1 TB cream | ≥ 6 servings/day | ≤ 3 servings/day |
| 8. Sweets | 4 g sugar or 8 fluid oz | ≥ 10 servings/week | ≤ 5 servings/week |

Abbreviations: DASH = Dietary Approaches to Stop Hypertension; ox = ounce; g = gram.
|                        | % (95% CI)       | CD                |
|------------------------|------------------|-------------------|
| **Overall (N)**         | 10,741           | 4412              |
| **Age group**           |                  |                   |
| 18–44 years            | 68.7 (67.3–70.1) | 74.0 (71.8–76.2)  |
| 45–64 years            | 26.7 (25.5–28.0) | 29.0 (26.4–31.5)  |
| ≥65 years              | 4.6 (4.0–5.2)    | 8.9 (6.8–10.9)    |
| **Sex**                |                  |                   |
| Male                   | 48.6 (47.2–49.9) | 45.9 (43.7–48.2)  |
| Female                 | 51.4 (50.1–52.8) | 45.1 (42.6–48.0)  |
| **BMI**                |                  |                   |
| Normal/underweight     | 25.4 (24.2–26.7) | 23.1 (21.2–25.0)  |
| Overweight             | 38.1 (36.7–39.5) | 35.7 (32.8–38.7)  |
| Obesity                | 36.9 (35.0–38.6) | 33.6 (30.8–36.5)  |
| **Study center**       |                  |                   |
| Bronx                  | 30.6 (28.1–31.2) | 24.1 (20.8–27.4)  |
| Miami                  | 23.1 (21.2–25.0) | 22.1 (18.5–25.7)  |
| Chicago                | 34.5 (32.8–36.6) | 33.6 (30.8–36.5)  |
| **Education**          |                  |                   |
| Not reported            | 9.1 (8.0–10.1)   | 4.9 (4.0–5.6)     |
| High school            | 29.0 (27.5–30.6) | 33.9 (32.1–36.7)  |
| > high school           | 40.7 (38.9–42.6) | 34.7 (32.1–38.2)  |
| Household income       |                  |                   |
| < $20,000              | 39.9 (38.0–41.9) | 36.1 (32.6–39.5)  |
| > $20,000–$50,000      | 38.4 (36.9–40.9) | 32.6 (29.4–35.8)  |
| > $50,000              | 12.6 (10.8–14.4) | 15.7 (12.5–18.8)  |
| **Energy intake**      |                  |                   |
| Not reported            | 9.1 (8.0–10.1)   | 4.9 (4.0–5.6)     |
| Ter tile 1              | 30.1 (28.6–31.6) | 29.4 (27.3–31.6)  |
| Ter tile 2              | 34.0 (32.7–35.3) | 36.4 (34.2–38.5)  |
| Ter tile 3              | 35.9 (34.3–37.6) | 34.2 (32.6–36.5)  |
| **Marital status**     |                  |                   |
| Single                  | 36.9 (35.5–38.3) | 30.1 (28.6–31.6)  |
| Married/cohabiting     | 49.5 (47.8–51.3) | 39.9 (37.2–42.6)  |
| Never married           | 13.6 (12.7–14.6) | 12.3 (10.5–13.6)  |
| **US residence**       |                  |                   |
| US-born                 | 24.5 (22.8–26.1) | 24.1 (21.7–26.5)  |
| 0–10 years              | 23.5 (22.3–24.8) | 16.5 (14.3–18.7)  |
| > 10 years              | 44.5 (42.9–46.2) | 50.7 (47.9–53.4)  |
| **Language preference**|                  |                   |
| English                 | 25.9 (23.9–27.8) | 22.0 (19.6–24.4)  |
| Spanish                 | 74.1 (72.2–76.1) | 78.0 (75.6–80.4)  |
| Smoking status          |                  |                   |
| Never                  | 63.6 (62.1–65.0) | 64.9 (62.4–67.4)  |
| Former                  | 15.0 (14.1–16.0) | 17.5 (15.9–19.2)  |
| Current                 | 21.4 (20.1–22.7) | 27.8 (25.1–30.6)  |
| **Physical Activity (GPAQ)** |              |                   |
| Ter tile 1              | 30.7 (29.3–32.1) | 27.8 (25.9–30.7)  |
| Ter tile 2              | 34.6 (33.3–35.9) | 31.8 (29.2–34.4)  |
| Ter tile 3              | 34.7 (33.3–36.1) | 36.4 (34.0–38.7)  |
| **Anxiety Symptoms Score (STAS)** |         |                   |
| Ter tile 1              | 42.0 (40.5–43.6) | 39.9 (37.2–42.7)  |
| Ter tile 2              | 31.3 (29.9–32.7) | 32.8 (30.5–35.1)  |

< 0.001:“p” indicates statistical significance of a comparison with Hispanics/Latinos.

(continued on next page)
| Table 2 (continued) |   |
|----------------------|---|
| **Overall** |   |
| Depressive Symptoms Score (CESD-10) |   |
| 29.0 (22.5-35.4) | < 0.001 |
| Systolic BP (mm Hg), mean (95% CI) |   |
| 117.8 (117.4-120.9) | 0.001 |
| HDL (mg/dL), mean (95% CI) |   |
| 48.5 (48.4-48.8) | 0.008 |
| Sample Size |   |
| None |   |
| 54.8 (42.1-68.1) | 0.001 |
| Low HDL |   |
| 25.9 (14.2-40.9) |   |
| T2 Diabetes |   |
| 25.9 (14.2-40.9) | < 0.001 |
| Impaired fasting glucose |   |
| 25.9 (14.2-40.9) | < 0.001 |
| Waist circumference (cm), mean (95% CI) |   |
| 93.9 (93.6-94.1) | 0.001 |
| High waist circumference |   |
| 93.9 (93.6-94.1) | < 0.001 |
| a Not reported due to small sample size. |   |

All values were weighted for survey design and nonresponse and adjusted for age.
analyses used survey-specific procedures to account for the 2-stage sampling design, cluster sampling, and stratification. All analyses used SAS 9.4, and a p-value of < 0.05 was considered statistically significant.

### 3. Results

We found a weighted prevalence of MetS in HCHS/SOL of 23.9% (95% CI: 22.7–25.2). Table 2 shows the characteristics of our study population overall and by Hispanic/Latino heritage group. Briefly the prevalences of MetS, high blood pressure, high triglycerides, and high waist circumference tended to vary by Hispanic/Latino heritage group as did blood pressure, triglycerides, HDL, glucose, and waist circumference when measured continuously. Table 3 shows mean DASH score by characteristics of our study population. Overall, mean DASH score was 34.3 (95% CI, 33.9–34.6) ranging from 4.53 to 74.75. DASH scores tended to be highest among those with Mexican heritage (mean score 37.4, 95% CI, 36.9–37.9) and lowest among those with Puerto Rican heritage (mean 31.1, 95% CI 30.3–31.9 for differences across all heritage groups). DASH also tended to be higher among those recruited from the Miami and San Diego centers, and those with a higher household income or education. Finally, DASH scores tended to be higher in those who were married, living in the US for > 10 years but not US-born, English speaking, never smokers, who were more physically active, and who had lower depression symptoms scores.

Table 4 shows the odds ratios for associations of MetS and its five components per 10-unit increase in DASH score overall and by Hispanic/Latino heritage group. DASH score was associated with lower odds of MetS in Central Americans (OR: 0.82, 95% CI: 0.69–0.96), increased odds of high triglycerides in those with mixed or other heritage (OR: 1.47, 95% CI: 1.04–2.09), lower odds of impaired fasting glucose both overall and in those with Mexican heritage (OR: 0.91, 95% CI: 0.85–0.98; OR: 0.87, 95% CI: 0.78–0.97), and lower odds of high waist circumference in those with mixed or other heritage (OR: 0.63, 95% CI: 0.48–0.82). Removing nativity from these models did not substantively change our results (Table S1).

Table 5 shows the regression coefficients from the linear regression of DASH score and MetS components, overall and by Hispanic/Latino heritage. The linear regression coefficients were used to calculate the adjusted mean DASH score for each characteristic and its 95% confidence interval. The adjusted mean DASH score was calculated by summing the regression coefficients for each characteristic and multiplying by the characteristic value. For example, the adjusted mean DASH score for US-born was 32.2 (95% CI: 31.6–32.8) for those who were US-born and 35.6 (95% CI: 35.2–36.1) for those who were not US-born. The adjusted mean DASH score was highest among those who were married, living in the US for > 10 years, English speaking, never smokers, who were more physically active, and who had lower depression symptoms scores.
became marginally significant in the analysis of high triglycerides, waist circumference as well as between DASH and MetS prevalence in Central Americans. Our statistical analysis indicated that overall DASH score was associated with systolic blood pressure (B: −0.36, 95% CI: −0.69, −0.02) and diastolic blood pressure (B: −0.62, 95% CI: −0.88, −0.35) as well as fasting glucose (B: −0.39, 95% CI: −0.61, −0.17) and waist circumference (B: −0.70, 95% CI: −1.10, −0.30). DASH score was also associated with systolic blood pressure in Hispanics/Latinos of South American heritage (B: −0.89, 95% CI: −1.78, −0.004); diastolic blood pressure in Hispanics/Latinos of Central American (B: −0.73, 95% CI: −1.45, −0.01) and South American (B: −1.17, 95% CI: −1.86, −0.48); triglycerides (B: −6.28, 95% CI: −12.29, −0.28) and HDL (B: 0.89, 95% CI: 0.03, 1.74) in those of Central American heritage; fasting glucose in those of Mexican heritage (B: −0.48, 95% CI: −0.80, −0.15); and waist circumference in those of Dominican heritage (B: −1.61, 95% CI: −3.07, −0.15) and South American (B: −1.42, 95% CI: −2.48, −0.37) heritages. Removing nativity from these models did not substantially change our results, although our finding linking diet and HDL in Central Americans became marginally significant (Table S2). Our sensitivity analysis also found largely null results for the association between overall DASH score and MetS prevalence, though in this model DASH was protective against MetS in Central Americans (OR: 0.76, 95% CI: 0.64–0.91; remaining data available upon request).

4. Discussion

In this study, we found that DASH diet scores tended to vary by Hispanic/Latino heritage group. While few dichotomous MetS components were associated with DASH, we did find associations between DASH diet score and high triglycerides, fasting glucose, and waist circumference as well as between DASH and MetS prevalence in Central Americans. Our stratified analyses suggest that these associations were driven primarily by Hispanics/Latinos of Central and South American heritages. Higher DASH score was associated with lower blood pressure in each of these groups and overall, lower fasting glucose in those with Mexican heritage, lower triglycerides and HDL in those with Central American heritage, and lower waist circumference in those with South American heritage. DASH score was associated with the largest number of MetS components of interest in those with Central and South American heritages as well. These findings add to the literature on the complex relationships between diet and cardiometabolic health among Hispanics/Latinos of diverse heritages, and contrasting these studies may add important information on the mechanisms driving cardiometabolic outcomes in these populations.

Few prior studies specifically examined the DASH diet in diverse Hispanic/Latino groups. Two prior studies of DASH in Puerto Ricans found generally low scores (Mattei et al., 2017; Palacios et al., 2017) and a third study of older (primarily Mexican-American) Latinos found only moderate scores (Staiano et al., 2013) and suggested that lower scores among Hispanics/Latinos might reflect cultural factors. Several studies of DASH in Puerto Ricans (Staiano et al., 2013; Root and Dawson, 2013) populations, we and others (Mattei et al., 2017) found largely null associations among Hispanics/Latinos. Few prior studies specifically examined the DASH diet in diverse Hispanic/Latino groups. Two prior studies of DASH in Puerto Ricans found generally low scores (Mattei et al., 2017; Palacios et al., 2017) and a third study of older (primarily Mexican-American) Latinos found only moderate scores (Staiano et al., 2013) and suggested that lower scores among Hispanics/Latinos might reflect cultural factors. Several studies of DASH in Puerto Ricans (Staiano et al., 2013; Root and Dawson, 2013) populations, we and others (Mattei et al., 2017) found largely null associations among Hispanics/Latinos.
Average change in each MetS risk factor per each 10-unit overall DASH score increase and cardiometabolic outcomes by Hispanic/Latino heritage group (n = 10,741).

| Systolic BP (mm Hg) | Diastolic BP (mm Hg) | Triglycerides (mg/dL) | HDL (mg/dL) | Glucose (mg/dL) | Waist circumference (cm) |
|--------------------|---------------------|----------------------|------------|----------------|-------------------------|
| ⁎⁎⁎—0.62, 0.88, 0.02 | —0.30, 0.73, 0.01 | —0.27, 0.50, 0.00 | —0.26, 0.49, 0.00 | —0.22, 0.53, 0.00 | —0.18, 0.58, 0.00 |
| Mexican 4412 | —0.43, 0.88, 0.02 | —0.27, 0.50, 0.00 | —0.26, 0.49, 0.00 | —0.22, 0.53, 0.00 | —0.18, 0.58, 0.00 |
| Puerto Rican 1460 | —0.46, 0.88, 0.02 | —0.27, 0.50, 0.00 | —0.26, 0.49, 0.00 | —0.22, 0.53, 0.00 | —0.18, 0.58, 0.00 |
| Central American 1220 | 0.13, 0.73, 0.01 | —0.27, 0.50, 0.00 | —0.26, 0.49, 0.00 | —0.22, 0.53, 0.00 | —0.18, 0.58, 0.00 |
| Mixed, other 390 | 0.14, 0.73, 0.01 | —0.27, 0.50, 0.00 | —0.26, 0.49, 0.00 | —0.22, 0.53, 0.00 | —0.18, 0.58, 0.00 |

The overall model adjusted for Hispanic/Latino heritage group (overall analysis only), and all models adjusted for age, sex, site, nativity, smoking status, total alcoholic drinks per week, education, household income, triglycerides and HDL analyses only, antihypertensive medication for systolic BP and diastolic BP only, antidiabetic medication for fast glucose. Abbreviations: 95% CI (95% confidence interval). B = Effect estimate from linear regression models. *Denotes the p-value for a product term between DASH score and Hispanic/Latino heritage group for each outcome.

This study has limitations. First, the cross-sectional nature of this analysis limits ability to infer temporality; individuals with higher blood pressure may change their diet in response to a recommendation.
or intervention by a health professional. However, it should be noted that our observed associations all suggest null or protective relationships, consistent with previously published prospective studies of DASH and various cardiometabolic endpoints in other populations (Schwingshackl et al., 2018; Jones et al., 2018). Second, as with many dietary studies in HCHS/SOL, the use of 24-hour dietary recalls may suffer from measurement error (Mossavar-Rahmani et al., 2015) that underestimates dietary quality (Subar et al., 2015). As discussed above, DASH diet may omit or misclassify traditional elements of some Hispanic/Latino diets that are relevant to MetS and its related conditions. Thus validated, culturally-sensitive dietary measures may be warranted in this population. Third, although our analytical design was driven by hypothesized differences between heritage groups and by the prior work in HCHS/SOL, the number of comparisons does leave potential inflation of our type I error a concern. Thus these findings should be interpreted with caution until they can be independently validated. Finally our observed effect sizes, even where statistically significant, were generally small and thus may be of limited clinical significance. Nonetheless, by contrasting this study with other examinations of diet quality in HCHS/SOL, we add useful information to the literature on diet-related health risks in Hispanics/Latinos in the US.

5. Conclusions

Overall, DASH was not associated with MetS in this study from the HCHS/SOL, the largest epidemiological study of diverse Hispanics/Latinos in the US. In contrast to a prior study (Mattei et al., 2016) demonstrating associations between MetS and the AHEI, DASH revealed stronger associations with MetS components in Hispanics/Latinos of Central and South American heritage, in contrast to the stronger associations of AHEI with MetS overall and its components in Hispanics/Latinos of Mexican and Puerto Rican heritage. This contrast suggests that DASH scoring may better capture health effects of traditional diets in some Hispanic/Latino heritage groups, adding evidence that Hispanics/Latinos of diverse heritages should not be grouped together in population-based studies but rather analyzed in a heritage group-specific manner. These findings also add evidence suggesting that AHEI or Mediterranean diet score (or possibly an adapted DASH diet score) may be more applicable to traditional Hispanic/Latino diets and health; future research should explore these possibilities. Future research should also examine differences associated with specific heritage groups, and potential explanations for them (e.g., geographic proximity to the US and its ‘western’ dietary pattern, specific ingredients driving the observed associations, interactions with socio-cultural factors, and genetic heritage differences between groups).

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

Acknowledgments

The authors thank the staff and participants of HCHS/SOL for their important contributions. The investigators’ website may be found here: http://www.cccc.unc.edu/hchs/. The Hispanic Community Health Study/Study of Latinos is a collaborative study supported by contracts from the National Heart, Lung, and Blood Institute (NHLBI) to the University of North Carolina (HHSN268201300001/N01-HC-65233), University of Miami (HHSN268201300004/N01-HC-65234), Albert Einstein College of Medicine (HHSN268201300021/N01-HC-65235), University of Illinois at Chicago (HHSN268201300031/N01-HC-65236 Northwestern Univ), and San Diego State University (HHSN268201300051/N01-HC-65237). The following Institutes/ Centers/Offices have contributed to the HCHS/SOL through a transfer of funds to the NHLBI: National Institute on Minority Health and Health Disparities, National Institute on Deafness and Other Communication Disorders, National Institute of Dental and Craniofacial Research, National Institute of Diabetes and Digestive and Kidney Diseases, National Institute of Neurological Disorders and Stroke, NIH Institution-Office of Dietary Supplements. B. Joyce, L. Hou, and L. Van Horn were supported by the American Heart Association Children’s Strategically Focused Research Prevention Network. S. Castaneda, L. Gallo, G. Talavera, D. Sotres-Alvarez, and M. Daviglus were supported by the American Heart Association Go Red For Women Research Network.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2019.100950.

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