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Original article

Diet quality, inflammation, and the ankle brachial index in adults with or without cardiometabolic conditions

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SUMMARY

Background & aims: Diet quality may influence non-traditional cardiovascular disease (CVD) risk factors – namely, C-reactive protein (CRP) and the ankle-brachial index (ABI). Pre-existing traditional cardiometabolic conditions may confound this association. We aimed to determine whether diet quality was associated with high-risk CRP or ABI, independently from traditional cardiometabolic risk factors.
Methods: Baseline data were analyzed from US-Hispanics/Latinos aged 18–74 y without previously-diagnosed CVD participating in the population-based Hispanic Community Health Study/Study of Latinos cohort. Included were 14,623 participants with CRP data, and 7892 participants (≥45 y) with ABI data. Diet quality was measured with the Alternate Healthy Eating Index (AHEI).
Results: Nearly 35% of Hispanics/Latinos had high-risk CRP concentration and 6.3% had high-risk ABI (peripheral artery disease (PAD): 4.2%; arterial stiffness: 2.1%). After adjusting for sociodemographic and lifestyle factors, diabetes, hypertension, hypercholesterolemia, and obesity, the odds (95% confidence interval) of having high-risk ABI were 37% (5, 44%) lower per 10-unit increase in AHEI ($p = 0.018$). The association was marginally significant for PAD (0.77 (0.58, 1.00); $p = 0.05$), and non-significant for arterial stiffness ($p = 0.16$). Each 10-unit increase in AHEI was associated with 21% (10, 30%) lower odds of high-risk CRP ($p = 0.0002$) after similar adjustments. There were no significant interactions between AHEI and age, sex, ethnicity, smoking, or pre-existing cardiometabolic conditions for associations with ABI. The association between AHEI and high-risk CRP was stronger for those with diabetes (p-interaction < 0.0001), obesity (p-interaction = 0.005), or ages 45–74 y (p-interaction = 0.011).
Conclusions: Higher diet quality is associated with lower inflammation and less adverse ABI among Hispanics/Latinos, independently from traditional cardiometabolic risk factors.

1. Introduction

Non-traditional risk factors of cardiovascular disease (CVD) may improve the prediction of CVD risk when assessed together with traditional risk factors such as biological and cardiometabolic markers [1–4]. Two of these novel non-traditional CVD risk factors are C-reactive protein (CRP), an inflammatory marker, and the ankle brachial blood pressure index (ABI), a marker of subclinical vascular disease, namely peripheral arterial diseases (PADs) or arterial stiffness. Each marker has been estimated to be an independent risk factor for cardiovascular events [2,3,5,6]. Because of

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the potential role of non-traditional risk factors on CVD-risk prediction, it is imperative to identify health behaviors that may prevent them.

Consuming a healthy diet is well known to prevent and control traditional cardiometabolic risk factors for CVD, such as type 2 diabetes, obesity, hypertension, and high blood cholesterol [7]. The literature on diet and non-traditional markers is sparser. While the majority of studies suggest a significant inverse association between indices of diet quality and CRP [8–18], some have shown null results [19,20] or associations modified by other risk factors [21]. Population-based studies on diet quality and ABI measures are limited and are more inconsistent [22–24,15,25].

Discrepancies in findings may be due to variations in study design and sample size, characteristics of the population, statistical model adjustment, and definition of diet quality. Several indices of diet quality have been used to study diet–disease associations. Particularly, the Alternate Healthy Eating Index (AHEI) captures multiple foods and nutrients with recent and strong evidence of association with lower disease risk, and it uses absolute measures to define the components according to cutoffs relevant to disease risk [26–28]. Furthermore, there is ample evidence that traditional and non-traditional biological risk markers co-occur [4,29]. Thus, statistical models testing the association between diet quality and non-traditional risk factors, especially those of cross-sectional design, should adjust for traditional cardiometabolic factors to properly control for confounding and better determine the strength of the association independently from traditional markers [4,29]. Few of the aforementioned studies on diet quality and CRP or subclinical vascular disease fully adjusted for cardiometabolic conditions [11,17,29].

Thus, this study aimed to determine the extent to which AHEI is associated with high-risk CRP and ABI (PAD and arterial stiffness), after adjusting for traditional cardiometabolic risk factors. Secondly, we aimed to determine if traditional risk factors modulated the association between diet and CRP or ABI. We investigated these questions in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL), a cohort that shows low to moderate scores of diet quality [30] and high prevalence of cardiometabolic risk factors [31]. Notably, US-Hispanics/Latinos present high CRP concentrations [32–34] and high-risk ABI levels [33]. Determining the association of diet with non-traditional CVD risk factors can reinforce the merits of following a healthy diet as a clinically-relevant primordial and primary behavioral strategy that could prevent further CVD.

2. Materials and methods

2.1. Study population and data collection

Baseline data collected between 2008 and 2011 from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) were used for this analysis. HCHS/SOL is a community-based prospective cohort study of 16,415 Hispanic/Latino individuals [35]. Potentially eligible individuals were identified from randomly selected households, following a stratified two-stage area probability sampling of household addresses in each of four U.S. field centers (Chicago, IL; Miami, FL; Bronx, NY; and San Diego, CA). Eligible participants had to be community-dwelling men and women (not institutionalized or on active military duty), living in the identified household, ages 18–74 y, self-identified as having Hispanic/Latino ethnicity (hereafter referred using their country of origin), able to attend a field center clinic, and not planning to move within 6 months. All participants signed informed consent. The institutional review boards of each field center, coordinating center, reading centers, and the National Heart, Lung, and Blood Institute approved this study.

Data collection has been described in detail previously [31,35]. Briefly, standardized clinical assessments and interviews were conducted by centrally-trained personnel in the participant's preferred language during a visit to one of the study centers. Participants self-reported their demographic and socioeconomic characteristics, medical diagnoses and use of medications (self-reported and scanned by interviewer), and family history of main chronic diseases, including coronary heart disease.

2.2. Dietary assessment and definition of diet quality

Dietary assessment and the definition of AHEI have been described in detail previously [30,36,37]. Briefly, two 24-h recalls were administered in the participant's language of preference, one in-person at the baseline visit and one via telephone or in-person within 5–90 days of the baseline visit. We excluded recalls with energy intake <1st or >99th sequence-sex-specific percentile, or deemed unreliable by the interviewer. Foods and nutrients were analyzed using the multiple-pass methods of the Nutrition Data System for Research (NDSR) software version 11 from the Nutrition Coordinating Center at University of Minnesota, which includes Hispanic/Latino foods.

The AHEI-2010 includes 11 dietary components: vegetables without potatoes, whole fruit without fruit juice, whole grains, sugar sweetened beverages and fruit juice, nuts and legumes, red and processed meat, *trans* fat, omega-3 fatty acids, polyunsaturated fatty acids, sodium, and alcohol. Each component was created by adding the corresponding NDSR food subgroups. Predicted usual intake amounts for each component were then estimated using the National Cancer Institute method. Each component was scored from 0 to 10 as continuous (prorated intermediate values) from minimal to maximal observance of the recommended amount of each item. Lastly, individual components' scores were summed. AHEI scores ranged from 0 to 110 (unhealthiest to healthiest).

2.3. Outcomes definition

A Roche Modular P Chemistry Analyzer was used to analyze serum high-sensitivity CRP (Roche Diagnostics Indianapolis, IN). CRP values were categorized as either low-risk (<1.0 mg/L), moderate-risk (1.0–3.0 mg/L), elevated-risk (>3.0–10.0 mg/L), or acute inflammation (>10.0 mg/L). A dichotomous high-risk CRP category was defined as >3.0 mg/L vs. low-risk ≤3.0 mg/L [38].

The ankle brachial index was measured using standardized procedures as previously described [33]. Participants aged ≥45 y were measured for appropriate cuff size, and four cuffs were placed on each ankle and each upper arm. While the participant was lying down and rested, systolic blood pressures were measured once, starting with the right arm, at the bilateral brachial, anterior tibial, and posterior tibial arteries. Limb-specific ABI was computed as the highest ipsilateral ankle artery pressure divided by the highest brachial artery pressure. This ankle-to-arm SBP ratio was used as the final ABI, using the lower of the two limb values. PAD was defined as having an ABI ≤ 0.90 (based on evidence of a doubling in risk of total mortality, cardiovascular mortality, and major coronary events) [39], and arterial stiffness was defined as ABI ≥ 1.40 (based on evidence of increased risk of poor arterial compressibility resulting from stiffness and calcification) [39–41]. Given that both classifications reflect elevated risk for cardiovascular death or event [39–41], and following previous examples [42,43], a combined category of high-risk ABI included those with either PAD or arterial stiffness.

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