1.a. Full Title: Association of DASH diet pattern with left ventricular structure and function in middle-aged and older adults: ARIC

b. Abbreviated Title (Length 26 characters): DASH diet and LV function.

2. Writing Group:
   Writing group members: So Yun Yi, Lyn M. Steffen, Tom Mosley, Casey M. Rebholz, Amil Shah

I, the first author, confirm that all the coauthors have given their approval for this manuscript proposal. ___SYY___ [please confirm with your initials electronically or in writing]

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3. Timeline:
Oct – Mar: Literature review
Nov: Organize and write introduction
Nov-Dec: Write the methods section; develop more specific analysis plan
Dec – Apr: Conduct analysis
Feb – Apr: Write the results section, include tables and figures
Apr – May: Write the discussion section
May-June – Request co-authors to review and comment
Jun: Submit to ARIC P&P for review; revise the manuscript as needed
Jul-Aug: Submit to journal
4. **Rationale:**

There are about 6.5 million (2.5%) adults in the U.S. who have heart failure (HF), with an estimated annual cost of $69.7 billion by 2030 (1). African American (AA) females and males have the highest prevalence of HF, 3.9% and 2.6%, respectively, compared to whites, Hispanics, and Asians (1). Risk factors for heart failure include diabetes, high blood pressure, obesity, and unhealthy behaviors such as high sodium intake, smoking, and physical inactivity as well as other factors (2). Because the prevalence of diabetes is increasing (3), the prevalence of heart failure is also likely to increase. In addition, high blood pressure is associated with structural and functional changes in heart and blood vessels such as LV dysfunction and LV hypertrophy (LVH) (4-7), which may also lead to HF.

Numerous studies have been conducted examining the effects of nutrients (8-12), foods (13-15), and dietary patterns (16-20) on cardiovascular disease (CVD) and its risk factors. Dietary patterns such as Mediterranean and Dietary Approaches to Stop Hypertension (DASH) diets have been associated with better cardiometabolic health. The Mediterranean diet pattern was associated with better LV structure and function among participants without known CVD in the Multi-Ethnic Study of Atherosclerosis (MESA) (21) and among patients who have acute coronary syndrome (22). A diet pattern characterized by high intakes of high glycemic index foods, high-fat meats, cheese, or processed foods and low intake of fruit, vegetables, soy, green and black tea, low-fat dairy desserts, seeds and nuts, and fish was unfavorably associated with LV mass and systolic function among MESA participants without CVD (23). Also, in a randomized clinical trial (RCT) of overweight type 2 diabetes patients without CVD, a low-carbohydrate diet improved diastolic cardiac function (24). Similarly, in another MESA investigation, investigators reported the DASH diet was associated with favorable LV function among whites, Chinese, AA, and Hispanics (25). In a clinical trial of 13 hypertensive heart failure patients with preserved ejection fraction, the low-sodium DASH diet improved ventricular diastolic function, arterial elastance, and ventricular-arterial coupling (26).

The DASH RCT, designed to test the effects of a dietary pattern high in potassium, calcium, magnesium, and fiber on blood pressure, successfully demonstrated reduced blood pressure in adults with systolic blood pressure of less than 160 mmHg and diastolic blood pressure of 80 to 95 mmHg (27). In addition to blood pressure, the DASH diet improved CVD risk factors such as insulin sensitivity (28), fasting glucose (29), inflammation (30), and oxidative stress (31). These CVD risk factors may mediate the association of the DASH diet with LV structure and function. Given these associations, the DASH diet may also be associated with better LV structure and function. However, few studies have been conducted in AA examining dietary intake relative to cardiac phenotypes. Therefore, further investigation of the potential benefits of the DASH diet pattern on LV structure and function is needed.

5. **Main Hypothesis/Study Questions:**

The objective of this study is to determine the relationships of the DASH diet pattern, along with food groups included in the DASH diet pattern, with blood pressure, LV mass, LV hypertrophy, and systolic and diastolic function. We hypothesize that the DASH diet is associated with better LV structure and function in African-Americans who attended the ARIC Jackson field center visit 3 exam and in both AA and Caucasians ARIC participants who attended the visit 5 exam at the four field centers.
6. Design and analysis (study design, inclusion/exclusion, outcome and other variables of interest with specific reference to the time of their collection, summary of data analysis, and any anticipated methodologic limitations or challenges if present).

**Study Design:**
1) Cross-sectional: average of visit 1 and 3 dietary intake relative to visit 3 cardiac phenotypes (measured in Jackson population).
2) Longitudinal: average of visit 1 and 3 dietary intake relative to visit 5 cardiac phenotypes (measured at all ARIC field centers).

**Study Population:** 1) African-Americans who attended the ARIC Jackson field center at visit 3 and had an echocardiogram; and 2) all ARIC participants who attended the visit 5 exam and had an echocardiogram.

**Inclusion criteria:** Participants who have diet data at visits 1 and 3 and who have echo data at visit 3 or visit 5.

**Exclusion criteria:**
1) for the Jackson only analysis: prevalent CVD including HF at visits 1-3; outlying energy intake, missing more than 10 food responses on the FFQ, missing visit 1 diet data
2) for all field center analyses: prevalent CVD including HF at visits 1-5; outlying energy intake, missing more than 10 food responses on the FFQ, missing visit 1 diet data

**Measurements:**
**Exposure variables:** average of visit 1+3 food groups (servings) that make up the DASH diet pattern; the DASH diet pattern score will be created (27) from averaged visit 1+3 food groups. For fruit, vegetables, nuts and legumes, low-fat dairy, and whole grains, participants in the highest quintile will receive a score of five, those in the 4th quintile will receive a score of 4, and so on. For sweetened beverages and red/processed meat, scoring will be reversed. The score of each component will be summed and the overall score will be ranged from 7 (no adherence) to 35 (perfect adherence) (32).

**Outcome variables:** 1) from Jackson Echo substudy: visit 3 LV mass index (LVMI; LV mass/height^2), LV systolic function (LV ejection fraction) and diastolic function (Doppler mitral inflow peak velocity of E wave (E), Doppler mitral inflow peak velocity of A wave (A), E/A diastolic filling velocity ratio), Doppler mitral velocity time integral of E wave (e’), and E/e’ ratio.
2) Visit 5 LVMI, LV ejection fraction, left atrial volume index, E, A, E/A ratio, e’. E/e’ ratio, average peak longitudinal strain, average peak radial strain, and average peak circumferential strain.

**Confounding factors:** age, sex, education, energy intake, smoking, alcohol drinking status, physical activity, antihypertensive medication use, and heart rate.

**Mediators:** body mass index (BMI), diabetes, and blood pressure.

**Effect modification or confounder (visit 5): race**

**Analysis Plan:**
The DASH diet pattern and quantiles* of the diet pattern score will be created; heart structure and function variables will be created.
1) Analysis of Jackson data: Multivariate linear regression analysis will evaluate the relations of
1) the average DASH diet pattern score and 2) the food groups that make up the DASH score
with visit 3 heart structure and function (Jackson population) adjusting for potential
confounding factors.
2) Analysis of longitudinal data: Multivariate linear regression we will evaluation the average
DASH diet pattern score and food groups that make up the DASH score with visit 5 heart
structure and function (all field center participants) adjusting for potential confounding
factors as well as for attrition due to loss to follow-up or death using inverse probability
weighting.
Several models will be developed adjusting for potential confounding factors (model 1 adjusted
for demographic characteristics plus energy intake; model 2 adjusted for model 1 plus lifestyle
factors; model 3 adjusted for model 2 plus potential mediators BMI, diabetes, and blood
pressure. Effect modification by race will be tested in the longitudinal analysis.

Proposed tables include:
Table 1. Baseline characteristics of ARIC participants stratified across quantiles* of the DASH
diet pattern score
Table 2. Food group intake stratified across quantiles* of the DASH diet pattern score
Table 3. Mean of cardiac phenotypes at visit 3 and for visit 5 stratified across quantiles* of the
DASH diet pattern.

* The number of quantiles will depend on sample size.

7.a. Will the data be used for non-CVD analysis in this manuscript? _____ Yes ______ No
b. If Yes, is the author aware that the file ICTDER03 must be used to exclude persons
with a value RES_OTH = “CVD Research” for non-DNA analysis, and for DNA
analysis RES_DNA = “CVD Research” would be used? _____ Yes _____ No
(This file ICTDER has been distributed to ARIC PIs, and contains
the responses to consent updates related to stored sample use for research.)

8.a. Will the DNA data be used in this manuscript? _____ Yes ______ No
8.b. If yes, is the author aware that either DNA data distributed by the Coordinating
Center must be used, or the file ICTDER03 must be used to exclude those with value
RES_DNA = “No use/storage DNA”? _____ Yes _____ No

9. The lead author of this manuscript proposal has reviewed the list of existing ARIC
Study manuscript proposals and has found no overlap between this proposal and
previously approved manuscript proposals either published or still in active status.
ARIC Investigators have access to the publications lists under the Study Members Area of
the web site at: http://www.cscce.unc.edu/aric/mantrack/maintain/search/dtSearch.html
_____ Yes _____ No
10. What are the most related manuscript proposals in ARIC (authors are encouraged to contact lead authors of these proposals for comments on the new proposal or collaboration)?

1182 (DASH and CVD) and 1749 (DASH and HF)

11.a. Is this manuscript proposal associated with any ARIC ancillary studies or use any ancillary study data? __X__ Yes ____ No

11.b. If yes, is the proposal
________ A. primarily the result of an ancillary study (list number* __________)
________ B. primarily based on ARIC data with ancillary data playing a minor role (usually control variables; list number(s)* __________ __________ __________)

*ancillary studies are listed by number at https://www2.cscc.unc.edu/aric/approved-ancillary-studies

Dr. Mosley’s Echo study done at visit 3 at the Jackson field center

12a. Manuscript preparation is expected to be completed in one to three years. If a manuscript is not submitted for ARIC review at the end of the 3-years from the date of the approval, the manuscript proposal will expire.

12b. The NIH instituted a Public Access Policy in April, 2008 which ensures that the public has access to the published results of NIH funded research. It is your responsibility to upload manuscripts to PubMed Central whenever the journal does not and be in compliance with this policy. Four files about the public access policy from http://publicaccess.nih.gov/ are posted in http://www.cscc.unc.edu/aric/index.php, under Publications, Policies & Forms. http://publicaccess.nih.gov/submit_process_journals.htm shows you which journals automatically upload articles to PubMed central.
REFERENCES


17. Schwingshackl L, Hoffmann G. Diet Quality as Assessed by the Healthy Eating Index, the Alternate Healthy Eating Index, the Dietary Approaches to Stop Hypertension Score, and Health Outcomes: A Systematic Review and Meta-Analysis of Cohort Studies. J Acad Nutr Diet. 2015;115:780–800.


