ARIC Manuscript Proposal # 3301

PC Reviewed: 12/11/18 **Status: _____** **Priority: 2**
SC Reviewed: _____ **Status: _____** **Priority: ____**

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]**

First author: **So Yun Yi**
Address: 1400 S 2nd St, Apt. A209, Minneapolis, MN 55454

Phone: 612-625-9307 Fax: 612-624-0315
E-mail: yixxx250@umn.edu

ARIC author to be contacted if there are questions about the manuscript and the first author does not respond or cannot be located (this must be an ARIC investigator).

Name: Lyn Steffen
Address: 1300 S 2nd St, Suite 300, Minneapolis, MN 55454

Phone: 612-625-9307 Fax: 612-624-0315
E-mail: steff025@umn.edu

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 4^{th} 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 __X__ 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 __X__ 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.cscc.unc.edu/aric/mantrack/maintain/search/dtSearch.html

___X___ 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

_X_ 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

1. Benjamin EJ, Virani SS, Callaway CW, Chang AR, Cheng S, Chiuve SE, Cushman M, Delling FN, Deo R, de Ferranti SD, et al. Heart Disease and Stroke Statistics—2018 Update: A Report From the American Heart Association . Circulation. 2018. CIR.0000000000000558 p.
2. Kishi S, Teixido-Tura G, Ning H, Venkatesh BA, Wu C, Almeida A, Choi EY, Gjesdal O, Jacobs DR, Schreiner PJ, Gidding SS, Liu K, Lima JAC. Cumulative Blood Pressure in Early Adulthood and Cardiac Dysfunction in Middle Age The CARDIA Study. J Am Coll Cardiol. 2015;65:2679–87.
3. Mendola ND, Chen T-C, Gu Q, Eberhardt MS, Saydah S. Prevalence of total, diagnosed, and undiagnosed diabetes among adults: United States, 2013–2016. NCHS Data Brief, no 319. Hyattsville, MD: National Center for Health Statistics. 2018.
4. He J, Ogden LG, Bazzano LA, Vupputuri S, Loria C, Whelton PK. Risk factors for congestive heart failure in US men and women: NHANES I Epidemiologic Follow-Up Study. Arch Intern Med. 2001; 161:996–1002.
5. Heckbert SR, Post W, Pearson GD, Arnett DK, Gomes AS, Jerosch-Herold M, Hundley WG, Lima JA, Bluemke DA. Traditional cardiovascular risk factors in relation to left ventricular mass, volume, and systolic function by cardiac magnetic resonance imaging: the Multi-Ethnic Study of Atherosclerosis. J Am Coll Cardiol. 2006; 48:2285–2292.
6. Levy D, Larson MG, Vasan RS, Kannel WB, Ho KK. The progression from hypertension to congestive heart failure. JAMA. 1996; 275:1557–1562.
7. Bacon SL, Sherwood A, Hinderliter A, Blumenthal JA. Effects of exercise, diet and weight loss on high blood pressure. Sport Med. 2004;34:307–16.
8. Graudal NA, Hubeck-Graudal T, Jürgens G. Effects of low-sodium diet vs. high-sodium diet on blood pressure, renin, aldosterone, catecholamines, cholesterol, and triglyceride (cochrane review). Am J Hypertens. Nature Publishing Group; 2012;25:1–15.
9. Aburto NJ, Ziolkovska A, Hooper L, Elliott P, Cappuccio FP, Meerpohl JJ. Effect of lower sodium intake on health: systematic review and meta-analyses. BMJ. 2013;346:f1326–f1326.
10. Threapleton DE, Greenwood DC, Evans CEL, Cleghorn CL, Nykjaer C, Woodhead C, Cade JE, Gale CP, Burley VJ. Dietary fibre intake and risk of cardiovascular disease: systematic review and meta-analysis.
11. D'Elia L, Barba G, Cappuccio FP, Strazzullo P. Potassium intake, stroke, and cardiovascular disease: A meta-analysis of prospective studies. J Am Coll Cardiol. 2011;57:1210–9.
12. Gobbo LC Del, Imamura F, Wu JHY, Otto MCDO, Chiuve SE, Mozaffarian D. Circulating and dietary magnesium and risk of cardiovascular disease : a systematic review and meta-analysis of prospective studies. Am J Clin Nutr. 2013;98:160–73.
13. Steffen LM, Kroenke CH, Yu X, Pereira MA, Slattery ML, Van Horn L, Gross MD, Jacobs DR Jr. Associations of plant food, dairy product, and meat intakes with 15-y incidence of elevated blood pressure in young black and white adults: the Coronary Artery Risk Development in Young Adults (CARDIA) Study. Am J Clin Nutr. 2005;82:1169–367.

14. Alexander DD, Bylsma LC, Vargas AJ, Cohen SS, Doucette A, Mohamed M, Irvin SR, Miller PE, Watson H, Fryzek JP. Dairy consumption and CVD: a systematic review and meta-analysis. Br J Nutr. 2016;115:737–50.
15. Ness AR, Powles JW. Fruit and vegetables, and cardiovascular disease: a review. Int J Epidemiol. 1997;26:1–13.
16. Ndanuko RN, Tapsell LC, Charlton KE, Neale EP, Batterham MJ. Dietary Patterns and Blood Pressure in Adults : A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Adv Nutr. 2016;7:76–89.
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.
18. Weng LC, Steffen LM, Szklo M, Nettleton J, Chambless L, Folsom AR. A diet pattern with more dairy and nuts, but less meat is related to lower risk of developing hypertension in middle-aged adults: The atherosclerosis risk in communities (ARIC) study. Nutrients. 2013;5:1719–33.
19. Salehi-Abargouei A, Maghsoudi Z, Shirani F, Azadbakht L. Effects of Dietary Approaches to Stop Hypertension (DASH)-style diet on fatal or nonfatal cardiovascular diseases-Incidence: A systematic review and meta-analysis on observational prospective studies. Nutrition. 2013;29:611–8.
20. Rodríguez-Monforte M, Flores-Mateo G, Sánchez E. Dietary patterns and CVD: a systematic review and meta-analysis of observational studies. Br J Nutr. 2015;114:1341–59.
21. Levitan EB, Ahmed A, Arnett DK, Polak JF, Hundley WG, Bluemke DA, Heckbert SR, Jacobs DR, Nettleton JA. Mediterranean diet score and left ventricular structure and function: the Multi-Ethnic Study of Atherosclerosis. Am J Clin Nutr. 2016;104:595–602.
22. Chrysohoou C, Panagiotakos DB, Aggelopoulos P, Kastorini C, Kehagia I, Pitsavos C, Stefanadis C. The Mediterranean diet contributes to the preservation of left ventricular systolic function and to the long-term favorable prognosis of patients who have had an acute coronary event. Am J Clin Nutr. 2010;3:47–54.
23. Liu L, Nettleton J a, Bertoni AG, Bluemke D a, Szklo M. Dietary pattern , the metabolic syndrome , and left ventricular mass and systolic function : the Multi-Ethnic Study of Atherosclerosis. Am J Clin Nutr. 2009;362–8.
24. Von Bibra H, Wulf G, St John Sutton M, Pfützner A, Schuster T, Heilmeyer P. Low-carbohydrate/high-protein diet improves diastolic cardiac function and the metabolic syndrome in overweight-obese patients with type 2 diabetes. IJC Metab Endocr. 2014;2:11–8.
25. Nguyen HT, Bertoni AG, Nettleton JA, Bluemke DA, Levitan EB, Burke GL. Dash eating pattern is associated with favorable left ventricular function in the multi-ethnic study of atherosclerosis. J Am Coll Nutr. 2012;31:401–7.
26. Hummel SL, Seymour EM, Brook RD, Sheth SS, Ghosh E, Zhu S, Weder AB, Kovacs SJ, Kolias TJ. Low-Sodium DASH Diet Improves Diastolic Function and Ventricular-Arterial Coupling in Hypertensive Heart Failure With Preserved Ejection Fraction. Circ Hear Fail. 2013;6:1165–71.

27. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, Lin PH, Karanja N. A clinical trial of the effects of dietary patterns on blood pressure. N Engl J Med. 1997;336:111–24.
28. Shirani F, Salehi-Abargouei A & Azadbakht L. Effects of Dietary Approaches to Stop Hypertension (DASH) diet on some risk for developing type 2 diabetes: a systematic review and meta-analysis on controlled clinical trials. Nutrition 2013;29:939–47.
29. Azadbakht L, Mirmiran P, Esmaillzadeh A, Azizi T, Azizi F. Beneficial effects of a Dietary Approaches to Stop Hypertension eating plan on features of the metabolic syndrome. Diabetes Care. 2005;28:2823-31.
30. Azadbakht L, Surkan PJ, Esmaillzadeh A, Willett WC. The Dietary Approaches to Stop Hypertension eating plan affects C-reactive protein, coagulation abnormalities, and hepatic function tests among type 2 diabetic patients. J Nutr. 2011;141:1083-8.
31. Asemi Z, Samimi M, Tabassi Z, Sabihi S, Esmaillsadeh A. A randomized controlled clinical trial investigating the effect of DASH diet on insulin resistance, inflammation, and oxidative stress in gestational diabetes. Nutrition. 2013;29:619–24.
32. Haring B, Selvin E, He X, Coresh J, Steffen LM, Folsom AR, Tang W, Rebholz CM. Adherence to the Dietary Approaches to Stop Hypertension (DASH) Dietary Pattern and Risk of Abdominal Aortic Aneurysm: Results from the Atherosclerosis Risk in the Communities (ARIC) Study. JAHA, 2018; 7:e009340.