DIETARY ASSESSMENT IN AFRICAN AMERICANS: METHODS USED IN THE JACKSON HEART STUDY

Teresa Carithers, PhD; Patricia M. Dubbert, PhD; Errol Crook, MD; Brenda Davy, PhD; Sharon B. Wyatt, RN, CANP, PhD; Margaret L. Bogle, PhD; Herman A. Taylor, Jr, MD; Katherine L. Tucker, PhD

Objectives: The dietary assessment methods used in the Jackson Heart Study (JHS) with the entire cohort and a subset of the cohort who participated in a diet and physical activity substudy (DPASS) are reported. These methods were employed to validate culturally explicit data collection instruments developed by Delta Nutrition Intervention Research Initiative (NIRI) for assessing dietary intake in an all African-American cohort.

Design: A validation/calibration design was employed. A short food frequency questionnaire (FFQ) was used with all JHS participants ($N=5302$). A long FFQ and four 24-hour diet recalls were used for the subset of DPASS participants ($n=449$).

Outcome Measures: Completion rates and preliminary macronutrient intakes are reported for the cohort and DPASS methods.

Results: Participants (5302) in the JHS full cohort completed the short FFQ. Of these, 572 were enrolled in the DPASS. A total of 506 participants completed four 24-hour dietary recalls, and 499 completed all six measures, including the long FFQ. Validation of dietary instruments in African Americans will help assure that valid conclusions can be drawn regarding the effects of diet on cardiovascular disease in this population. (*Ethn Dis*. 2005; 15[suppl 6]:S6-49–S6-55)

Key Words: African Americans, Calibration Study, Diet, Jackson Heart Study

From the Department of Family and Consumer Sciences, University of Mississippi, Oxford (TC); School of Medicine (PD, SBW, formerly TC), School of Nursing (SBW), and the Examination Center, Jackson Heart Study (PD, SBW, formerly TC, HAT), University of Mississippi Medical Center, Jackson; G.V. (Sonny) Montgomery Veterans Affairs Medical Center, Jackson (PMD), Mississippi (PMD); Department of Medicine, University of South Alabama, Mobile, Alabama (EC); Department of Human Nutrition, Foods and Exercise, Virginia Tech University, Blacksburg, Virginia (BD); Agricultural Research Service, United States Department of Agriculture, Washington, DC (MLB); Jean Mayer, USDA Human Nutrition Research Center on Aging, Tufts University, Boston, Massachusetts (KLT).

INTRODUCTION

Nutritional assessment in any population is difficult. Optimal data collection instruments are not available to assess the influence of ethnicity-specific dietary patterns on health outcomes. Food frequency questionnaires (FFQ) are widely used to assess usual dietary intake and to rank individuals with regard to food and nutrient intake within populations. However, they have generally been based on national food patterns. No satisfactory, culturally sensitive instrument for use in epidemiologic studies specifically with African Americans, particularly those living in the South, is currently validated.[1,2] The Jackson Heart Study (JHS), a large, single-site, prospective, epidemiologic study of the risk factors and causes of cardiovascular disease (CVD) in southern African Americans, provided an opportunity to identify and validate optimal dietary assessment methods to use with African-American populations in the southern United States. Together with the Delta Nutrition Intervention Research Initiative (NIRI), the JHS included a dietary assessment of all participants and a diet and physical activity substudy (DPASS) for calibration and validation. Validation of an ethnically specific dietary assessment instrument will contribute to more accurate investigation of the risk relationship of both diet and physical activity to CVD risks in African Americans. Although diet and physical activity were both assessed within the DPASS, the physical activity components are described in a separate manuscript.[3]

Address correspondence and reprint requests to: Teresa Carithers, PhD, RD, LD; Chair and Associate Professor; Dept. of Family and Consumer Sciences; The University of Mississippi; 106 Lenoir Hall, P.O. Box 1848; University, MS 38677-1848; 662-915-7371; 662-915-7039 (fax); carither@olemiss.edu

BACKGROUND

Most forms of CVD, including stroke, coronary heart disease (CHD), congestive heart failure (CHF), and hypertension are more prevalent in the South compared with other regions of the United States.[4] Cardiovascular disease (CVD) mortality in Mississippi is higher across all race and sex groups than the national average.[5] The factors causing these regional geographic differences are unclear, but lower average socioeconomic status, unhealthy dietary habits, physical inactivity, and a higher prevalence of obesity in the South may contribute. Established lifestyle risk factors for CHD include smoking, obesity, physical inactivity, and an atherogenic diet.[6] Typical diets in the southern United States are high in fat, cholesterol, and sodium and low in dietary fiber, potassium, calcium and magnesium.[7] Each of these dietary factors is associated with increased risk of CVD.[8–13]

Racial differences in dietary intake have been reported for total fat, cholesterol, micronutrients including ascorbic acid, calcium, magnesium, vitamin B6, folate, and dietary fiber; racial differences also exist in vegetarian dietary patterns.[14–21] Studies of variation in prevalence of obesity and physical inactivity have often compared African Americans with other racial groups.[22–26] In some of these studies, many other

factors are confounded with ethnicity, complicating the search for causal influences. Research that elucidates the contribution of diet and physical activity patterns to morbidity and mortality among African Americans is limited. Research investigating sex differences in nutrient intake within the African-American population is needed to better explain variations in health.

In epidemiologic studies similar to the JHS, the FFQ has proven to be a useful tool to rank the usual nutrient intake of individuals and assess the role of dietary components on health outcomes.[27,28] The most widely used FFQs capture the foods most commonly consumed in the United States. For example, the Block questionnaire is based on a food list of data from national surveys,[29] and the Willett questionnaire is based on a nationwide sample of dietary intake from nurses and health professionals.[30,31] In these questionnaires, nutrient intake is captured for most individuals in nationally representative studies. However, the intakes of individuals who follow dietary patterns that differ from the national norm may be underestimated. Specific cultural and other foods are not included or may be incorrectly estimated because recipes for commonly used foods differ.

The 66-item Willet FFQ was used in the Atherosclerosis Risk in Communities (ARIC) study, an epidemiologic study that preceded the JHS (and ARIC participants are included in the JHS cohort). Use of this instrument was considered in the JHS to facilitate correlating findings between the two studies. Close investigation revealed the lack of validation in a southern African-American population, limiting its usefulness for the JHS.

INSTRUMENT SELECTION/ DEVELOPMENT

A thorough review of the literature was conducted to identify the most appropriate methods and instrument(s) to use in assessing dietary intake in a cohort of African Americans. A working group of JHS investigators and three nationally recognized nutrition epidemiologists evaluated five leading instruments (two of which were in the developmental phase) and made the final determination. Specific criteria for instrument selection included: 1) the ability to compare findings with previous studies, including the ARIC study; 2) low participant burden; and 3) potential for validity within the African-American community. The Delta NIRI FFQ[32] was selected as the most robust instrument with the greatest potential for validation in an African-American cohort. A close collaboration and memorandum of understanding was formed between the JHS and the Delta NIRI to formalize validation of the Delta NIRI FFQ within the JHS and DPASS cohorts.

The development of the Delta NIRI FFQ within an African-American population in the Lower Mississippi Delta (LMD) is detailed in previous literature.[32] Portion sizes were assessed by using the FOODS 2000 24-hour dietary recall data. Means, medians, modes, and distributions were examined. Because the range of portion sizes was large, four options were defined, corresponding to small, medium, large, and extra large. The medium portion was selected as a standard measure close to the mode or median of reported sizes. In general, sizes were determined as: small= ½ medium, large=1 ½ medium, and extra large=2+ medium. The draft form was field-tested at several community sites in the LMD and in Jackson, Mississippi. More than 100 questionnaires were administered to individuals in the region, and reactions, difficulties, or questions by respondents were noted and used to improve the recipes, serving sizes, and other assumptions behind the development of a FFQ that would accurately measure the unique cultural patterns of the JHS cohort.

The DPASS was implemented to investigate the validity of a short and long FFQ for use in assessing the dietary intake patterns of African Americans. The original Delta NIRI FFQ required ≈45–60 minutes to administer. The JHS investigators established that JHS participant burden criteria would allow only 20 minutes for dietary assessment. The close collaboration developed between the JHS and Delta NIRI staff, coupled with calibration techniques newly available to nutrition epidemiologists, allowed the development of a shorter FFQ, which requires only 20 minutes to administer.

The Delta NIRI FFQs are desirable because the short FFQ, with 158 items, is a categorical subset of the longer, 283-item version. In addition to strong cultural components and expanded potential to capture supplemental intake, both FFQs have several open-ended questions to capture ingestion not included in the standard questions. This unique capability provided the potential for the Delta NIRI FFQs to capture usual intake patterns more accurately than other existing FFQs.

METHODS

Calibration Design

A calibration/validation design was used to compare the short and long Delta NIRI FFQs by using four 24-hour dietary recalls conducted over various seasons and differing days of the week. Traditional validation designs had no mechanism to integrate new information that might become available during the course of a study. New statistical techniques used in calibration designs allow for corrections in diet assumptions throughout the course of a research study to integrate new information and enhance overall accuracy. Because the shorter FFQ was a categorical subset of the larger FFQ, the ultimate objective of the DPASS was for both FFQs to be validated during the course of study.

Even in the most optimally designed diet study, the potential for random measurement error exists, particularly with self-reported diet data. For this reason, additional biomarker measures were taken to strengthen the validation of dietary instruments. Biomarkers are independent and objective physiological measures that optimize diet validation studies. As more appropriate biomarkers are identified and laboratory techniques are available, specific dietary/nutrient and physiological relationships can be determined. The few biomarkers currently available have become a new standard for dietary consumption validation. Serum tocopherols and carotenoids and urinary sodium measurements were included as biomarkers for the DPASS calibration/validation of both FFQs and 24-hour dietary recalls.

Sample

Sampling for the JHS is described elsewhere.[33] African-American men and women (5302 in all) between the ages of 35–84 (with some younger than 35 and older than 84 included in the family study) were recruited for the main study. For the DPASS, 500 participants (250 males and 250 females) were targeted for enrollment. The JHS cohort participants were pre-screened to determine DPASS eligibility by using data from the home induction interview to classify potential participants as to sex, age (younger, 34–64; older, ≥65), socioeconomic status (SES) (poverty/non-poverty), and physical activity level (high, low). The SES classification was determined by using self-reported data. While this method of determination differs from more sophisticated estimates that will be used in later JHS papers, poverty was determined for DPASS eligibility purposes as follows.

A poverty classification was given to participants who answered ''yes'' to questions that confirmed they qualified and were receiving Aid to Dependent Children (ADC), receiving food stamps, were on other welfare programs, or qualified and were receiving supplemental security income (SSI) or reported family income <$8,000 per year. A non-poverty classification was given to participants answering ''no'' to these same questions and whose reported family income was ≥$8,000 per year. Participants were classified in the lower physical activity group if their interview responses indicated no leisure time vigorous activity and work activity the same as or lighter than others of their age and no exercise and sports participation. Initially, all JHS participants who met eligibility criteria were invited to participate in DPASS, with a focused attempt to recruit persons who had completed the ambulatory blood pressure and 24-hour accelerometer monitoring. The JHS participants received a DPASS brochure at the completion of their JHS exam that described the DPASS objectives and requirements and encouraged participation should they be contacted at a later date.

The DPASS staff contacted eligible JHS participants one to two months after completion of the JHS exam to explain the requirements of the DPASS, answer questions, and confirm their willingness to participate. A record-of-calls report was used to monitor responses, develop interview schedules, and provide contact information for follow-up calls to participants who could not be contacted or those who wished to be contacted at a later date. Materials inviting them to enroll in DPASS were mailed to potential participants after several attempts to contact them by phone or if their contact information was no longer accurate. If an individual agreed to participate, an appointment was scheduled over the phone and a reminder was mailed. On their first visit, DPASS participants were asked to complete an informed consent document approved through the University of Mississippi Medical Center's institutional review board. Ideally DPASS encounters were scheduled monthly, however, missed appointments and the participant's personal requests extended the time between visits for some. Once participants were enrolled and had completed their first two visits, retention in the study was viewed as a higher priority than maintaining a strict timeline between encounters.

After the first 100 participants were enrolled, the investigators examined their characteristics in terms of sex and age to determine the need for oversampling to assure adequate variation in all age, sex, SES, and physical activity characteristics. This need for variation resulted in a focused effort to recruit males.

Data Collection: Diet

24-Hour Dietary Recalls

Four 24-hour recalls were obtained from participants through face-to-face interviews conducted by trained research dietitians. To assure variability of intake, all participants agreed to provide one 24-hour recall scheduled on Monday to capture Sunday's intake and one Saturday encounter to capture Friday's intake. Additional visits were scheduled on different days of the week to capture as much variability as possible. Scheduling repeated intakes of dietary measures over a six-month period of time assured seasonal variability. The initial short FFQ captured usual intake patterns for six months before the first JHS exam visit. The additional DPASS encounters, including the long FFQ completed at the last visit, provided dietary data for the total duration of one year. Reported intakes were entered directly into the Nutrition Data System (NDS), a computerized nutrient analysis program that was developed by the University of Minnesota for use in nutrition research.[34]

Food Frequency Questionnaires

Usual intake was assessed with: 1) the short Delta NIRI FFQ, which was administered by trained JHS clinic staff

during the participant's initial JHS examination; and 2) the long Delta NIRI FFQ, which was administered by the DPASS staff at the fifth and final DPASS visit. This process provided a total of six encounters per DPASS participant.

Quality Control

Diet calibration requires critical attention to detail and accuracy. The JHS and DPASS staff received extensive training on administration of diet FFQs. All FFQs were reviewed for entry errors by DPASS staff. Five percent of the FFQ administrations were audiotaped and received a secondary level of review by DPASS staff. Feedback regarding accuracy and necessary data edits was routed through the clinic manager, who was the immediate supervisor of the JHS clinic interviewers. If the percent of accuracy fell below the DPASS standard for acceptability, interviewers were required to attend a retraining session. The DPASS interviewers who conducted 24-hour recalls were certified through the Minnesota NDS program. All 24-hour recalls were audiotaped to allow immediate and thorough review of entries. Five percent of these interviews were routed for a secondary level of quality review by the DPASS principal investigator.

Additional quality control checks were conducted by DPASS staff to identify and immediately correct any variance from DPASS protocol and to identify micro/macronutrient outliers. On completion of FFQ quality control, they were transferred to the Dietary Assessment and Epidemiology Research Program at the Jean Mayer United States Department of Agriculture (USDA) Human Nutrition Research Center on Aging (HNRC) at Tufts University for scanning. The 24-hour dietary recalls were reviewed for quality control, batched (50 participants/batch), and sent to Tufts University for a third-level quality review including identification of micro/macronutrient outliers. Edits were completed by DPASS staff and returned to Tufts. Once all data editing and review was completed, a new cumulative SAS data set was generated and transferred back to the JHS Coordinating Center for future analyses.

Data Collection: Biomarkers

Serum Biomarkers

Tocopherols and carotenoid analyses were conducted by using stored serum specimens. Estimation of carotenoids and tocopherols was performed by the Carotenoids and Health Laboratory at Tufts University with high-performance liquid chromatography (HPLC) as described by Yeum et al.[35] After extraction with ether, the samples were analyzed with a reverse-phase HPLC system. Carotenoids and tocopherols were quantified by determining peak areas in the HPLC chromatograms, calibrated against known standards. Detailed results and specific laboratory techniques conducted for these two biomarker validations will be described in future publications.

Urine Biomarkers

Sodium measurements from 24-hour urine collections are considered useful biomarkers for validating sodium intake. The JHS participants were asked to perform a 24-hour urine collection for evaluation of sodium, potassium, and creatinine; however, sodium is the only measure used as a nutrient biomarker. A single 24-hour urine collection was selected to avoid any adverse effect of urine collection on cohort retention. These were requested during the JHS initial exam. Because participation rates were suboptimal, the decision was made in late 2001 to collect spot urines on all the remaining JHS cohort participants. The 24-hour urines continued to be collected on the JHS participants who were willing. All DPASS participants were asked to perform repeat 24-hour urine collections to take advantage of the more extensive dietary data collected from the JHS/DPASS cohort subset. Positive relationships developing during the repeated DPASS encounters enhanced the willingness of these participants to provide initial and/or repeat urine collections.

In addition to a collection kit, an instruction sheet on the appropriate procedures for 24-hour urine collection was provided and reviewed with each participant. Each participant started the collection on an evening within one week of the first exam, discarding the first specimen, and ending 24 hours later, saving the last specimen. Start and finish times were recorded, as well as any lost specimens. Participants were contacted by JHS staff within 24 hours of the participant-specified collection dates to remind the participant to collect the urine and to verbally review the instructions. In this way, urine sodium, potassium, and chloride values were not influenced greatly by the fast required by the JHS examination, nor would the length of time from serum creatinine measurement and other data collected during the exam be too long to allow comparisons. Participants were given some leeway as to when they performed the collection to minimize problems with collecting in the workplace, transportation of samples, and cohort retention.

Collections were returned to the JHS Examination Center where total volume was determined and recorded. One aliquot from each participant from each 24-hour collection was provided to a local laboratory for the measurement of sodium, potassium, and creatinine (one per participant except in the 20% who performed repeat collections). Another aliquot was processed to determine urinary albumin excretion. Urine creatinine was used to validate that collections were complete. For every sixth participant, one extra aliquot was prepared from a randomly selected 24-hour collection and used for external quality control of the laboratory. Results

Table 1. JHS and DPASS participant enrollment and retention

Age Group	34–44 Years		45–54 Years		55–64 Years		65–74 Years		≥75 Years	
Sex	M	F	M	F	M	F	M	F	M	F
JHS enrolled	407	640	476	826	485	939	341	652	102	205
JHS short FFQ (n=5169)	388	615	460	791	464	893	319	621	97	190
JHS poverty	50	128	52	116	55	162	39	149	23	69
JHS non-poverty	308	431	354	605	658	364	265	422	66	95
DPASS enrolled	20	27	41	51	65	131	61	128	16	32
DPASS poverty	4	3	5	5	1	19	7	21	4	3
DPASS non-poverty	17	14	28	39	64	103	39	76	11	9
24-hour recall (1)	21	20	34	48	68	121	51	101	15	14
24-hour recall (2)	21	20	34	48	68	121	51	101	15	14
24-hour recall (3)	21	20	34	48	68	121	51	101	15	14
24-hour recall (4)	21	20	34	48	68	121	51	101	15	14
DPASS long FFQ	21	20	34	48	68	120	51	101	15	14
JHS 24-hour urine	45	84	68	150	95	225	76	172	24	41
DPASS 24-hour urine	6	8	12	22	31	50	21	47	10	7

JHS=Jackson Heart Study; DPASS=diet and physical activity substudy; M=males; F=females; FFQ=food frequency questionnaire.

of sodium validation will be reported in a future publication.

Data Analysis

The FFQ and the 24-hour recalls were analyzed for nutrient intake at the HNRC by using the Minnesota NDS database. This database builds from the USDA's national database to include more detail on brand name items and prepared foods and is widely considered to be the most complete nutrient database available. The mean intake of total energy, protein, fat, and carbohydrate as well as vitamins and minerals for the four 24-hour recall days will be compared to the respective mean intake from each FFQ with paired t tests. The means of the first two recalls will also be compared to the last two recalls to determine a "learned" effect exists. This finding can sometimes occur with repeated measures, when participants become too familiar with the process.

Correlations will be assessed with both Pearson and intraclass methods, and the level of agreement in quartile assignment will be assessed. In addition, Bland-Altman plots will be used to illustrate the differences between the two methods. These plot the distribution of the average of the two methods against the individual differences between methods. The resulting output shows if one method is over- or underestimates intake, relative to the other, and whether the difference is uniform or dependent on the level of intake. The two FFQs will be compared for reliability with paired t tests, intraclass correlations, and description of interquartile agreement.

Table 2. Macronutrient means for DPASS participants by sex

Males	Protein (g)	Fat (g)	Carb (g)	Energy (kcal)
Recalls	83	80	236	1991
LFFQ	77	83	291	2226
SFFQ	80	84	295	2232
Females	**Protein (g)**	**Fat (g)**	**Carb (g)**	**Energy (kcal)**
Recalls	62	64	210	1645
LFFQ	64	72	268	1958
SFFQ	66	73	293	2054

DPASS=diet and physical activity substudy; LFFQ=long food frequency questionnaire; SFFQ=short food frequency questionnaire.

RESULTS

The JHS cohort included 5302 participants. The DPASS enrolled 569 eligible JHS participants. Oversampling was conducted to allow for a possible 10% dropout rate. A total of 499 (175 males and 324 females) participants completed all six encounters. Table 1 shows the level of participant retention and encounters completed throughout the JHS and DPASS by age, sex, and SES. Female participants were easier to recruit into the study than male participants. Although more women were enrolled in the DPASS than men, the overall retention rates were similar for males (87%) and females (88%).

Comprehensive results of the calibration/validation analyses will be reported in a future manuscript. Preliminary results indicate acceptable agreement between both FFQs and 24-hour recalls for mean macronutrient intakes in the DPASS participants (Table 2). Males consumed more macronutrients than females. Within the DPASS population, higher numbers of men than women reported use of

Table 3. Supplement use by DPASS participants by sex (n=499)

Use Supplements	Yes	No
Males	104	87
Females	184	124
Total	288	211

DPASS=diet and physical activity substudy.

nutritional supplements (Table 3). More female participants in DPASS used supplements (60%) than did male participants (54%).

DISCUSSION

The JHS assessed dietary patterns of African Americans by using a short FFQ in all participants and a long FFQ and 24-hour dietary recall accompanied by biomarker validation in a subset of the total JHS cohort. The calibration model used by the DPASS assures the long-term utility of both instruments to optimally investigate African-American dietary components and cultural intake patterns. Once validation is completed, such comprehensive and culturally sensitive dietary assessment tools will greatly expand the capacity of researchers to investigate the many diet-related health disparities in the African-American population.

Several limitations should be addressed. Although efforts were made to oversample males, the DPASS sample had a much higher female participation rate. This result is consistent with the overall JHS sample.[36] Completion rates for the FFQs, 24-hour recalls, and serum and plasma carotenoids and tocopherols were adequate to provide statistically significant validation findings. The numbers of participants who completed the 24-hour urine protocols were much lower and thus may not be as useful as a validation biomarker.

The appropriate staffing of dietary studies is often debated and underestimated. The DPASS used both trained nutritionists/dietitians and non-nutritionists to complete study activities. Although most dietary instruments can be administered, with appropriate training, by nonnutritionists/dietitians, the DPASS investigators found that the quality-control time expenditures were greatly increased for those activities performed by nonnutrition personnel. This extended level of personnel expenditure for quality control should be a consideration when designing dietary studies; it justifies involving at least some trained nutrition staff in study activities.

Willingness of previous JHS participants to participate in the DPASS was attributed to a positive experience during the JHS exam, dedicated and enthusiastic DPASS staff, the participant's desire to "help someone," and a participant's personal interest in health issues relating to their risk of heart disease. Attention to participant retention is a high priority in dietary studies such as this because of the increased participant burden from repeated measures. Data regarding recruitment responses were recorded during enrollment calls and follow-up DPASS visits and reported on DPASS monthly encounter reports. Although participants within the JHS were given a small financial incentive upon completion of their initial exam requirements, DPASS participants did not receive an additional financial incentive. The DPASS interviewers acquired several small, inexpensive incentives that were offered to participants at the end of each encounter. The lack of financial incentives did not appear to affect participation rates.

The JHS has the potential to contribute significantly to epidemiologic investigations in African-American populations. The DPASS will contribute a short FFQ (requiring only 20 minutes to administer) that will allow continued diet investigation, even in studies with significant participant burden or other time constraints. Without such a tool, dietary assessment might have been omitted or underestimated because of lack of time. The long FFQ will allow investigators who desire more comprehensive investigations to use a more detailed instrument with unique, open-ended capabilities. In addition, the 24-hour recall data contribute actual and comprehensive consumption and supplement information in a representative sample of African Americans, which will help illuminate the specific cultural dietary intake patterns thought to contribute to the broad scope of health disparities that exist within the African-American community.

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