THE JACKSON HEART STUDY OF THE FUTURE

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INTRODUCTION

The 10th Anniversary Jackson Heart Study (JHS) Scientific Conference was a fertile time of intense discussion, exchange of ideas and creative flights of scientific thought. During a concentrated 48-hour period, numerous recommendations on research topics, study design enhancements and ancillary studies using the expansive JHS database were advanced, deepening and broadening the thinking of JHS investigators and NIH program staff. The JHS 2010 Scientific Conference offered renewed vision and guidance for future cardiovascular disease research to include novel phenotype characterization, imaging techniques, genomics, epigenomics and more.

In this synthesis, we provide answers two key questions: ''Why is the JHS important?'' and ''What may the JHS look like in the future?'' The vision of the future of the JHS is divided into five-year timeframes with the next five years being devoted to maximum use of the rich repository of data collected from the cohort between September 2000 and 2013 and the development and execution of priority ancillary studies. The second five-year period is envisioned as being devoted to optimal use of a database that has been expanded via continued surveillance activities and ancillary studies, inclusive of interventional studies, as well as the emergence of new scientific directions. The vision of the JHS presented here presumes a longevity that approaches that of other uniquely useful longitudinal studies. While this is clearly not guaranteed, it is useful to project what unique contributions such longevity might allow.

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WHAT THE JACKSON HEART STUDY MAY LOOK LIKE IN THE FUTURE

Future contributions from the JHS will be determined, in large part, by the data collection of the past. Data collected to date took place during three examination cycles: Exam 1 from September 2000–March 2004; Exam 2 February 2005–December 2008; and Exam 3, February 2009–January 2013. The database is comprehensive and includes data ranging from genetic information to psychosocial variables. Table 1 displays the range of JHS data categories, by exam, including data on biologic markers, clinical presentation, insurance claims and events. Table 2 displays categories of data collected via surveys and interviews.

The JHS database contains as many as 6500 data points on each of approximately 5000 participants. While a number of significant findings have already been reported, realization of the full potential of the JHS database and resources will require greater utilization of the phenotype and genotype datasets and blood samples by researchers across the country. Over the next five years, the JHS will contribute scores of manuscripts to the scientific literature and continue to develop ancillary studies to explore diverse topics; dozens have been published since the close of the conference reported in this issue of *Ethnicity & Disease*. Indeed, between the conclusion of the anniversary conference and this publication of its proceedings, more than 50 manuscripts have been published. Presenters and participants in discussion groups suggested more than 60 research areas/ideas for manuscripts and/or ancillary studies and study design enhancements using the JHS database, ensuring a full pipeline of analyses. These are loosely grouped according to the conference subject areas; outcomes, health/risk factors, social determinants, biomarkers/imaging, and genetics in Tables 3–7; Table 8 lists ideas for study design enhancements.

A FUTURE OF MAXIMUM SCIENTIFIC PRODUCTIVITY FROM THE JHS: DEVELOPMENT OF AN INTERNATIONAL ''COLLABORATORY'' FOR RESEARCH, TRAINING AND SERVICE

The 10th Anniversary JHS Conference is a dramatic illustration of ''where good ideas come from.'' Breaking out of silos (eg, genetics, metabolic disease, cardiology, sociology, radiology, other disciplinary or institutional affiliations or natural affinities) created a ferment of ideas, which will set the stage for novel discovery. This direction, that is, increasing interdisciplinary interactions and

Table 1. JHS Data Categories by Exam

Data Category	Exam 1	Exam 2	Exam 3
Anthropometry			
Standing height	x	x	x
Neck girth	x		
Waist girth	x	x	x
Weight	x	x	x
Blood pressure			
Sitting	x	x	x
Ankle-brachial	x		x
Ambulatory (pre/post)	x		
Imaging			
Computerized tomography; chest and abdomen. Calcium scoring and fat deposition		x	
Magnetic resonance imaging; cardiac structure/function (non-contrast)		x	x
MRI with contrast; cardiac structure/ function, great vessel flow velocities			
Ultrasound (echo and carotid)	x		x
Electrocardiography (12 lead)	x		x
Echocardiography	x		
Blood analytes, multiple biomarkers	x	x	x
Urine			
24 hour	x		
Spot	x	x	x
Genetics (Affy 6.0, Illumina IBC, Microsatelite, Copy Number Variation)			
DNA	x	x	
Cryopreservation (family component)	x		
Cryopreservation (non-family component)		x	
Geographic (geocoding, linked census, built environment		x	
Centers for Medicare/Medicaid (CMS) linked: procedures, treatment patterns, resource costs	x	x	x
Events, both ascertained from surveillance and physician adjudicated (heart failure, stroke, coronary heart disease, myocardial infarction)	x	x	x
Pulmonary function	x		

broad collaborations, of modern epidemiology is expounded by many and embraced by the JHS as it intentionally evolves toward the ideal of establishing an international collaboratory.

Cogburn[13] describes a collaboratory as ''more than an elaborate collection of information and communications technologies; it is a new networked organizational form that also includes social processes, collaboration techniques, formal and informal communication, and agreement on norms, principles, values, and rules.''

The principal expression of the ''new networked organizational form'' around the JHS hub is its burgeoning web of Vanguard Centers and Working Groups. In 2011, the JHS formalized a process for establishing Vanguard Collaborative Centers. These Vanguard Centers are entities designed to offer an enhanced mechanism for sharing complete JHS data (within the bounds of participant consent) with key, motivated and productive collaborators in order to stimulate optimal scientific productivity.

An overlapping web of interaction integrates the activities of JHS-resident investigators, Vanguard Center investigators and other independent scientists. The first generation of working groups is focused on areas targeted by both JHS and the recent NHLBI-sponsored Targeted Analysis of Jackson Heart Study Data projects, and is guided by established principles and approach (see JHS Website www.jhs.jsums.edu).

The newly formed JHS working groups are defined by the following priority areas:

- Psychosocial
- Diabetes
- Obesity
- Diet and Physical Activity
- Heart Failure
- Inflammation
- Stroke
- Myocardial Infarction
- High Blood Pressure
- Chronic Kidney Disease
- Cognitive Impairment

The rationale for using working groups focused on priority areas is that JHS believes working groups have the best potential for maximizing the benefits of collaborations. While doing so, the opportunities for developing young investigators at far-flung locales and among underrepresented minorities are being enhanced.

Our intention is that the JHS models for collaboration will be transformative in setting the bar for researcher expectations of partnerships and data sharing from population studies. What we have to offer is an innovative model for research collaboration that encompasses incubation of research ideas/ questions from conception through gestation to delivery of a mature idea to data sharing, analysis, and manuscript writing within a reasonable and

Table 2. Survey/Interview Data

Survey/Interview	Exam 1	Exam 2	Exam 3
Medication survey	x	x	x
Medical history	x	x	x
Health history/personal and family history	x		
Stroke symptoms	x	x	x
Renal disease		x	x
Chronic burden			x
Racism and discrimination	x		x
Depressive symptoms and dysthymia	x		x
Hassels and moods (a composite of validated assessment including 3 stress inventories, job strain, John Henryism, anger, hostility, neighborhood violence, coping etc)	x	x	x
Tobacco use	x		x
Alcohol and drug use	x		x
Montreal cognitive assessment			x
Sleep health care continuity and trust	x		
Physical activity	x		x
Personal data-socioeconomic status	x		x

monitored timeframe, and within an open science environment.

THE INTERVENTIONAL IMPERATIVE

The accumulation of evidence of a persistent and peculiarly high cardiovascular risk in this community, and the principle of prevention underlying much of epidemiologic research, underscore the need to expand upon the investigation of the causes of CVD among African Americans by testing approaches that will prevent disease in the future. Continued careful observational study should be augmented with equally intelligent interventional trials, which may begin to build a new set of data on efficacious and clinically effective approaches to interrupt the terrible trajectory of disease that this community is now experiencing. The combined JHS research and that of the Jackson (Miss.) site of the Atherosclerosis Risk in Communities (ARIC]) study represent a 24-year history of fruitful observation of the AA community of the Jackson Miss. MSA. The research accomplishments are numerous and the potential for future discovery is unlimited, as data analysis and ancillary studies progress. However, many consider that after two decades of observation, carefully planned, focused interventional studies are a timely and natural extension of this pioneering work.

Eckel recommended the launch of community-based intervention studies that address research questions similar to the following: (a) What settings are likely to be most conducive to weight management interventions (eg, worksites vs clinics or community-based locations) (b) What are the types and intensities of primary interventions that are most likely to be most successful (eg, weight tracking, calorie counting, physical activity and incentives, and secondary interventions such as, educational materials, weight maintenance and lifestyle classes/counseling)?[12] These studies would involve mostly non-JHS-cohort participants, but unique insights might be gained from inclusion of a small portion of the deeply phenotyped JHS cohort in carefully designed studies.

THE CONTINUED IMPORTANCE OF THE JACKSON HEART STUDY

The Jackson Heart Study will continue to be of importance for multiple reasons on local, national and global scales shown below:

1. The JHS is located in the state with the highest CVD mortality and morbidity statistics, where obesity is number one among multiple risk factors for CVD and where the risk burden for CVD is excessive.
2. The unique partnership among three academic institutions in Jackson, Mississippi adds to the importance of the JHS as a model for capacity-building among the institutions, as well as capacity-building via NHLBI/NIMHD-sponsored

Table 3. Using the Jackson Heart Study database to expand research on health services and outcomes

#	Recommendations
1	Assess quality of care using CMS linkage data.[1]
2	Use JHS data to contribute toward a ''Global Vascular Risk Score.'' [1]
3	Oversample around end points of CHF and atrial fibrillation (AF). [2]
4	Look at health service utilization as an emerging outcome.[1]
5	Develop more complex models to capture exposures across multiple domains (ie, social, physiological, physical, chemical etc) and assess the possibility of additive and synergistic effects among the many factors that drive health outcomes.[4]
6	Use information on silent heart attacks among patients who appear to be healthy to provide longitudinal data to better understand the cause of the silent heart attacks.[4]
7	Examine more closely renal function and CVD.[1]
8	Assess the relationship between lifetime risks and fatal and non-fatal events among African Americans.[5]
9	Tease out the rates of AF since African Americans have higher rates of risk factors but lower rates of AF and higher rates of ischemic stroke.[6]

Table 4. Using the Jackson Heart Study database to expand research on biomarkers and imaging

#	Recommendations
1	Assess left ventricular (LV) function differences in participants with and without evidence of asymptomatic congestive heart disease (CHD).[4]
2	Prediction of total atherosclerotic burden (CHD) from quantity of calcified plaque seen on CT.[4]
3	Include study of vascular phenotypes, ambulatory blood pressure and vitamin D/parathyroid hormone.[6]
4	Develop risk prediction models for CVD in African Americans (AA), which may include coronary calcium, comparable to those available in other ethnic groups.[4] Atherosclerosis, defined by coronary calcium score, should be considered in prediction of CVD events for African Americans.[7]
5	Prioritize analyses of the risk associated with specific fat depots /distribution measured by computed tomography (CT) and magnetic resonance imaging (MRI).[7]
6	Examine body fat distribution in relation to cardiovascular outcomes in the JHS as compared to other study cohorts to address health disparities in CVD.[7]
7	Imaging structural biomarkers, such as body fat distribution and coronary calcification, should be prioritized as a unique tool to examine the association of different obesity phenotypes with the development of CVD.[7]
8	Prospective studies should be considered to evaluate the power of fat depots in the prediction of cardiovascular disease in AAs.[7]
9	Correlate hemoglobin A1C findings among African Americans with the oral glucose tolerance test as a diagnostic indicator of Type 2 diabetes mellitus (DM), so that DM can be diagnosed with a single blood test.[6]
10	More study is needed on how adiponectin (ADPN) will perform longitudinally as a predictor of LVH.[7]
11	Pericardial adipose tissue (PAT) is a biomarker of visceral adipose tissue (VAT) that is significantly correlated with most cardiometabolic risk factors. PAT may exert a local effect on the coronary vasculature.[7]
12	Explore the relationship of MRI imaging data to myocardial function to determine whether such parameters can predict CVD events. (MRI can be more accurate than echocardiography and enable earlier detection of myocardial structural and functional abnormalities).[7]
13	Exploit extensive biomarker data, (serum and urine) to characterize surrogate endpoints in disease, health, nutrition or nutrition intervention. Link biomarker studies to imaging studies, where possible, to ultimately develop clinical surrogates for risk assessment.[7] Look at biomarkers for calibration of measures for AAs.[2]
14	Look at how serum vitamin D levels correlate with coronary artery calcium.[2]
15	Patterns of glycemia among AAs are uniquely high risk; JHS should prioritize exploration of important correlates/predictors of poor glycemic control in this heterogenous AA cohort.[6]

training and education programs to prepare students to enter careers in biomedical research. As well, this partnership model among the institutions provides an essential setting for cross-disciplinary engagement in a population-based, epidemiological study of CVD risk factors among African Americans that can be replicated in other settings with other special populations to optimize the contributions of many to benefit all Americans.

3. Kittles, from the perspective of the geneticist, emphasized that we must increase trans-disciplinary research efforts by engaging more social scientists in the conversation to gain better appreciation and understanding of critical non-ge-

Table 5. Using the Jackson Heart Study database to expand research on social determinants

#	Recommendations
1	Enhance understanding of why some risk behaviors more adversely affect the health of African Americans (AAs) compared to Whites as is the case for both alcohol and tobacco.[1]
2	Take a lead role in identifying how the normal adaptive and regulatory systems of AAs are affected by their harsh residential environments. JHS can shed light on how biological adaptation to their occupational and residential environments can lead some African Americans to have biological profiles that are different from other groups and have distinctive patterns of interactions between biology and psychosocial factors.[3]
3	More understanding should be sought on the role of perceived discrimination in order to understand disparities in hypertension, behavioral risk factors, and obesity and fat distribution, because health behaviors may be coping responses to experiences of discrimination among AAs.[8]
4	Consider how the environmental context interacts with individual-level SES, psychosocial factors, and traditional biomedical risk factors; consider individuals in the context of their physical environment and how it contributes to CVD disparities.[8]
5	Make significant contributions to an improved understanding of the contribution of social norms and belief systems that support resilience and provide protection against cardiovascular disease.[3]
6	Make a significant contribution to capturing repeated measures of exposure to social and psychosocial stressors over time, using a life-course perspective, to adequately monitor the dynamic nature of such exposures over the life course.[3]
7	Identify health-protective factors, ideal health factors and behaviors and resilience.[3]
8	Understanding the relative contribution of psychosocial factors, health status, and the social and physical environment to racial differences in sleep duration and quality and other disparities for multiple other CVD risk factors is an important research priority.[3]

Table 6. Using the Jackson Heart Study database to expand research on health risk factors

#	Recommendations
1	How can we explain a normal BMI and abnormal metabolic profile?[4]
2	What allows certain individuals to be healthy, regardless of BMI, and what allows certain groups to be more at-risk for disease in the future?''[4]
3	Identify the determinants of disparities and the optimal intervention strategies at each specific point of the disease continuum.[3]
4	Preventing heart disease and stroke by promoting ideal health eg, ''Life's Simple 7.''[9]
5	Develop a JHS Risk Prediction Model.[2]
6	Continue to validate the ideal CV health factor profile for AAs through the JHS data.[5]
7	Sleep deprivation associated with appetite and insulin secretion, shorter sleep associated with caloric intake and energy expenditure, as well as long sleep in relation to depression and/or sleep apnea.[10]
8	Design, test and implement public health and clinical policies that are aimed at primordial prevention to facilitate more individuals getting to middle age with the ideal health factor profile, not having developed risk factors or requiring treatment.[5]
9	Phenotype in detail normal weight participants from Framingham Heart Study (FHS) and JHS to understand precursors of hypertension and diabetes.[10]
10	Consider offspring of the JHS to aid in understanding of early life, sociocultural, genetic and gene-environment influences on CVD/loss of ideal CV health.[5]
11	Study sedentary behavior and physical activity using JHS data.[10]
12	Consider examining companion cohorts of AAs who are related to the JHS individuals but who live in a different environment.[5]
13	Examine body composition in the JHS in relation to outcomes, and comparing to other studies with comparable data.[10]
14	Understand the determinants of optimal health-related quality of life and develop interventions to reduce racial differences in the risk and protective factors, the onset, management progression, quality of life, impairment and survival of disease.[3]
15	Characterization of diet, physical activity and sleep in normal weight vs overweight participants in the cohort.[10]
16	Further focus on the richly phenotyped subcohort of the Diet and Physical Activity Substudy (DPASS).[10]

netic variables that should be explored.[10] This theme will be central to the JHS; the immense value of cross-disciplinary collaboration among seemingly disparate fields will be a well-spring of innovative work. The JHS is uniquely situated to accomplish this.

4. The JHS participants have bought into the importance of the JHS by responding to the invitation to come to the clinic for routine or expanded examinations and to the Jackson Medical Mall for events four times each year to keep them informed about the state of the study. The commitment of participants and the JHS community at-large to the study is a highly valued resource for engagement in ancillary and interventional studies.
5. The JHS aligns its scientific priorities with the NHLBI strategic plan. Most ideas on research topics and study design enhancements for manuscripts and ancillary studies using the JHS database can be aligned with the NHLBI Strategic Plan Goal 2: ''To improve understanding of the clinical mechanisms of disease and thereby enable better prevention, diagnosis and treatment.''[14] The emerging capacity of the JHS in building collaborative teams, modeling multidisciplinary teams and translation of research into practice, and prevention is related to NHLBI strategies 3, 4, 6, and 8: ''3) Increase the return from NHLBI population-based and outcomes research; 4) Establish and expand collaborative resources for clinical research''; 6) Support the development of multidisciplinary teams''; and 8) Bridge the gap between research and practice through knowledge networks.''[14]
6. The JHS objectives were designed to address the historical and social context of CVD, genetics, disease patterns, and risk factors. Because the study design was flexible enough

Table 7. Using the Jackson Heart Study database to expand research on genetics

#	Recommendations
1	Define genetic and lifestyle factors and their contribution to ideal CV health in AAs, while exploring novel or unique gene interactions among people of African ancestry.[5]
2	Invest in harmonizing JHS data (phenotypic) with other studies including AAs.[10]
3	Continue to explore the social determinants of health and other environmental exposures, that, when analyzed in the context and in relation to genetics, will allow development of a more-defined picture of how and when genes interact with the environment.[11]
4	Continue to study diet, lifestyle, socioeconomic status and other environmental exposures (eg, stress, discrimination, medical literacy, etc) independently of race to understand the gene-environment interaction that affects disease.[11]

Table 8. Conference participants' ideas on study design enhancements

#	Recommendations
1	Develop new methods to analyze large data sets, including systems biology and complex systems methods for epidemiological and clinical data.[2]
2	Look at the patient becoming a partner in his/her care via self-titration of anti-hypertensive medications to increase hypertension control.[6]
3	Engage the community where results are disseminated and interventions are developed.[8]
4	Use connectivity social networking sites, such as Twitter and Facebook, to monitor cardiac risk.[6]
5	Augment methods to include qualitative assessment of measures such as living histories.[2]
6	Use more community-based participatory research to design interventions.[2]
7	Plan interventions utilizing blood and urine biomarkers as independent and outcome variables (they enable faster, efficient clinical trials; help inform healthy diet choices; enable tracking of health concerns and decisions about care.[7]

to accommodate the addition of bio-imaging and biomarkers, the collection of these data from a large AA cohort became available.

The Jackson Heart Study is an ambitious and unique undertaking that is valuable to the local, national and global communities. The JHS is providing a model for transforming a legacy of heart disease among African Americans into a legacy of heart health on the path toward the resolution of cardiovascular health disparities for all Americans.

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