PHYSICAL ACTIVITY ASSESSMENT METHODS IN THE JACKSON HEART STUDY

Objectives: Physical activity measures used in exam 1 of the Jackson Heart Study (JHS), including the diet and physical activity substudy (DPASS), are described.

Design: The JHS physical activity (PAC) survey instrument was administered by interview. Accelerometer data, pedometer step counts, and additional questionnaire data were collected from volunteer subsamples of the cohort, including the DPASS.

Outcome Measures: The PAC assessed four different domains of physical activity (active living, work, home and garden, and sport and exercise indexes). The 24-hour accelerometer and pedometer monitoring provided objective measures for validation of cohort survey responses. The DPASS past week activity (PWA) questionnaire assessed time spent in moderate and vigorous activity during the previous seven days. Pedometer step counts for three days before three DPASS visits provided additional data for the DPASS analyses.

Results: 5296 respondents completed the PAC, 423 completed 24-hour accelerometer monitoring, and 499 completed the DPASS measures; 85 completed both 24-hour monitoring and DPASS measures. Initial analyses of leisure and sports activity items showed similar distributions for men and women and for the cohort and DPASS participants, in a bimodal distribution, with similar proportions reporting infrequent and frequent activity. The physical activity measures from the JHS can provide unique information about the association between physical activity, other risk factors, and cardiovascular disease in African Americans. (*Ethn Dis*. 2005;15[suppl 6]:S6-56–S6-61)

Key Words: Accelerometer, African Americans, Jackson Heart Study, Measurement, Pedometer, Physical Activity, Questionnaire

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INTRODUCTION

Physical activity was recognized as a risk factor for coronary heart disease (CHD) almost 40 years ago in the Framingham Heart Study.[1,2] Data from the Honolulu Heart Study in the 1980s also found physical activity to be among the lifestyle factors that predicted heart disease in Japanese-American men.[3] However, the extent to which the results from these studies could be generalized to African Americans was not known. In the 1980s, the Atherosclerosis Risk in Communities (ARIC) study was initiated, including a large cohort of African Americans in Jackson, Mississippi. Physical activity studies in the ARIC study revealed significant body mass index (BMI) by sex and race.[4] Notably, a study of excess incident type 2 diabetes in African-American and European-American ARIC participants revealed significantly lower leisure-time physical activity and higher rates of obesity in African-American compared with European-American women. These findings contributed to the conclusion that almost 50% of the excess risk for diabetes in African-American women might be related to potentially modifiable factors.[5]

Epidemiologic surveys consistently find that African Americans do not engage in as much leisure-time physical activity as European Americans[6] and are less likely to meet current public health guidelines for physical activity.[7,8] Physical activity levels are particularly low in the southeastern United States[9] and among African-American women.[10,11] In 2002, Mississippi ranked 47th of the 50 states for physical activity, when only 63.8% of African Americans, compared with 70.6% of Whites, reported engaging in physical activity during the past month. Although obesity has increased in all segments of the population, African-American women have the highest rates of overweight and obesity in the United States,[12] and Mississippi has the highest rates of obesity among the states.[13]

Higher rates of obesity and other physical inactivity-related health problems among African Americans[14,15] and results from the ARIC study suggest a need for further study of physical activity in African Americans. In the ARIC study, the association between CHD and physical activity scores observed in European-American men and women was not found in the African-American participants.[16] African-American participants in the ARIC study had lower levels of activity than European Americans and fewer (5% vs 15%) reported any vigorous activity. Another study, examining physical activity in relation to incident hypertension,[17] found the expected graded relationships between BMI and waist-to-hip ratio with exercise scores in European Americans but not African Americans. African Americans were much less likely to report playing a sport or exercising during leisure time compared with European Americans (47% vs 72%), and neither sports nor occupational physical activity scores were associated with reduced odds of developing hypertension in African Americans. The restricted range of physical activity

Table 1. Summary of Jackson Heart Study physical activity measures for exam 1

Measure	Participants	Description and Time(s) of Data Collection
Physical activity survey for cohort	JHS cohort participants	30-item interviewer-administered survey similar to ARIC instrument, with modifications designed to include some light-moderate activities; administered at home interview before clinical examination.
24-hour physical activity monitoring	JHS cohort participants	Accelerometer worn for 24 hours after clinical examination; pedometer worn concurrently; step count recorded by study assistant.
Past week activity recall	DPASS participants	12-item interview assessing type of activity at work, moderate, vigorous, and strength activities during past seven days; administered at each of the five DPASS visits.
Step counts	DPASS participants	Pedometer worn and step counts recorded for three days before three of the five DPASS clinic visits.

JHS=Jackson Heart Study; ARIC=Atherosclerosis Risk in Communities; DPASS=diet and physical activity substudy.

found in African Americans in ARIC could have obscured associations between physical activity and cardiovascular disease (CVD). However, the investigators also noted that the instrument used to assess physical activity in the ARIC study had never been validated in African Americans.

The Jackson Heart Study (JHS) expanded the Jackson, Mississippi, field site of the ARIC study to establish a new epidemiologic study to identify risk factors for development and progression of CVD in African Americans. A cohort of 5302 African Americans, 35–85 years of age and including surviving ARIC participants, was recruited from the Jackson metropolitan area. In addition to evidence for validity in African-American and minority populations, criteria for selecting the JHS physical activity assessment methods were to allow continuity with the ARIC study, minimize participant burden, and permit some validation of self-report data. The measures selected and described here included an interview survey for the overall cohort, 24-hour accelerometer monitoring for a subsample of cohort volunteers, and repeated past week activity interviews and step counts from the participants of the diet and physical activity substudy (DPASS). A summary of the measures is displayed in Table 1. The primary purpose of this paper is to describe the methods used for physical activity assessment in the JHS exam 1. Responses to selected items from the cohort interview measure are also presented as a preliminary description of the physical activity habits of the JHS participants. Psychometric analyses of the JHS instruments will be presented in separate manuscripts.

METHODS

Cohort Physical Activity Assessment Methods for the JHS Survey (Interview) Measure

Trained interviewers administered the JHS physical activity cohort instrument (PAC) at the home visit before the JHS clinical examination. The PAC has 30 items in four sections designed to obtain information about men's and women's physical activity habits in different settings. The PAC items are compiled to produce four separate scores or indexes for different domains of physical activity: active living; occupational activities; home, family, yard, and garden; and sports and exercise. The JHS PAC was derived from modifications to the Baecke physical activity survey,[18] which was also the parent instrument for the ARIC study's physical activity survey.[19] The JHS PAC is most similar to the Kaiser physical activity survey (KPAS),[20] another modification of the Baecke and ARIC activity questionnaires, that was designed in the 1990s to improve physical assessment in women and minorities. The KPAS added new items about caregiving, housework, and other home, yard, and gardening activities.[20,21] Ainsworth et al[20] examined the reliability and validity of the KPAS. Test-retest reliability correlations were high for each of the physical activity indexes (r=.79–.91, P<.01). Age-adjusted Spearman ρ correlations between sports/exercise index and active living index were moderate for VO_{2peak} (r=.34–.76, P<.01) and percent body fat (r=−.30 to −.59, P<.05). Correlations between similar activities assessed with the KPAS and detailed physical activity diaries had r=.03–.64. Examining data from an ethnically diverse sample of 2635 women ages 20–65, Sternfeld[21] found associations between level of activity and lower BMI, not having young children in the home, social support for exercise, motivation to exercise, and age, but demographic and psychosocial correlates of physical activity differed by domain. These findings showed good reliability and validity for the KPAS in a multiethnic sample.

The four-item active living section of the PAC is almost identical to the counterpart section on the KPAS. Two items from the Paffenbarger questionnaire[22,23] (number of city blocks walked and frequency of vigorous activity) were also included in this section of the PAC. The section on occupational activity is almost identical to similar sections on the KPAS and ARIC instruments. The sport and exercise index is the same as

that included on the KPAS and similar to the ARIC instrument except for the addition of new activity choices and the use of MET (multiples of resting metabolic rate, 1 MET=1 kcal/kg/hour) values of energy expenditure from the updated Compendium of Physical Activity published in 2000.[24] The seven-item home and garden section combined some items from the KPAS household and family care activities section to reduce administration time, modified other items to include activities often reported by men, and eliminated references to shoveling snow. The PAC can be obtained from the JHS web site: www.jsums.edu. The scoring for the PAC is complex, but follows the same procedures previously described for the KPAS[20] and ARIC[19] instruments.

24-Hour Physical Activity Monitoring

The JHS participants who volunteered for physical activity monitoring immediately following their clinic examination visit were provided with a Manufacturing Technology, Inc. (Model 7164 Actigraph, MTI, Fort Walton Beach, Fla) accelerometer. The 24-hour monitoring period ran concurrently with ambulatory blood pressure monitoring, which allowed retrieval of instruments by a study staff member the following day. The MTI accelerometer is a small, lightweight, unobtrusive, battery-powered electronic device capable of measuring the acceleration and deceleration of movement in a single vertical plane over a user-defined time period (epoch). Before distributing the accelerometers, study staff initialized each unit to sample data at one-minute intervals and instructed the participant in wearing the monitor in its pouch affixed to a belt at waist level a few centimeters to the right or left of the umbilicus. Participants were further instructed to remove the devices only while sleeping, bathing, or swimming. After the 24-hour monitoring period, the data from each accelerometer were downloaded to a digital file for later analysis. Previously established threshold values were then used to determine the amount of time spent performing light ($<$3.00 METs, $<$1952 counts/min), moderate (3.00–5.99 METs, 1952–5724 counts/min), and vigorous ($\geq$6.00 METs, $\geq$5725 counts/min) physical activity over the monitoring period.[25] A number of studies have shown that the accelerometer provides a valid estimate of activity-related energy expenditure across a broad range of activities under controlled laboratory[25–27] and free-living conditions.[27–29] An electronic pedometer (see below) was also affixed to the belt and was used to obtain objective data (steps/day) on ambulatory physical activity. Data for 24-hour monitoring were retrieved from 423 participants.

DPASS Physical Activity Assessment Methods

In addition to completing the PAC, the 499 participants of DPASS completed additional physical activity interview and step-count measures as described in this section.

DPASS Interview Measure

The past week physical activity recall (PWA) used in the DPASS was a modification of the 2001 interviewer-administered physical activity module developed for the US Centers for Disease Control and Prevention Behavioral Risk Factor Surveillance Survey.[30] Optional questions about frequency and duration of walking were also included in the PWA. Other PWA questions asked about the type of activity performed at work (mostly sitting and standing, mostly walking, or mostly heavy labor or physically demanding work), the frequency and duration of moderate and vigorous-intensity exercise, and participation in muscle strength and toning exercises during a usual week. Examples of moderate- and vigorous-intensity activities were given to help respondents differentiate between them. The validity and reliability of the PWA has been studied for individual items, ranging from Spearman r=.38–.58 and Kappa=.40 for validity and Spearman r=.44–.69 and Kappa=.52–.86 for one-month test-retest reliability.[31] The PWA was administered at each of the five DPASS return visits by a trained staff member.

DPASS Step Counts

The DPASS participants were also asked to wear a pedometer (Yamax SW 200, Yamax Corporation, Tokyo, Japan) for three days during the week before three of the diet recall return clinic visits to provide an objective measure of ambulatory activity. Participants were asked to record the daily total each evening in a log provided by the study staff. To minimize reactivity, participants were not informed of health promotion campaigns that have used pedometers to encourage increased physical activity or (daily) step totals associated with health related outcomes.[32] In 1996, Bassett et al[33] showed that the predecessor (Yamax DW-500) of the pedometer used in the JHS recorded average values for steps and distance within 1% of actual steps taken during a self-paced walk.

FINDINGS

As an initial evaluation of physical activity data with the JHS database, we examined responses to some of the PAC items for all respondents by sex and separately for those in the DPASS subsample. The items selected provide a brief summary of participation in leisure time moderate-intensity (walking) and sports activities. In this report, we present crude prevalence estimates; additional multivariable adjusted analyses will be undertaken in future analyses.

Table 2 displays responses to the item asking for frequency of walking at least 15 minutes at a time during leisure

Table 2. Frequency of walking at leisure

All Respondents				
	Women		Men	
Frequency	Number	Percent	Number	Percent
Less than once per month	1544	45.6	839	44.1
Once per month	184	5.4	82	4.3
Two to three times per month	266	7.9	182	9.6
Once per week	314	9.3	195	10.2
More than once per week	1081	32.9	606	31.8
DPASS Subsample				
Less than once a month	135	43.8	82	43.4
Once per month	12	3.9	6	3.2
Two to three times per month	32	10.4	16	8.5
Once per week	29	9.4	20	10.6
More than once per week	100	32.5	65	34.4

DPASS=diet and physical activity substudy.

Table 3. Frequency of sweating from exertion during leisure time

All Respondents				
	Women		Men	
Frequency	Number	Percent	Number	Percent
Less than once per month	1745	51.5	786	41.4
Once per month	136	4.0	72	3.8
Two to three times per month	221	6.5	175	9.2
Once per week	267	7.9	182	9.6
More than once per week	1018	30.1	686	36.1
DPASS Subsample				
Less than once a month	146	47.4	77	40.7
Once per month	12	3.9	3	1.6
Two to three times per month	23	7.5	18	9.5
Once per week	27	8.8	17	9.0
More than once per week	98	31.8	74	39.2

DPASS=diet and physical activity substudy.

Table 4. Frequency of playing sports or exercise during past year*

All Respondents Who Engage in Sports and Exercise				
	Women		Men	
Frequency	Number	Percent	Number	Percent
Less than once per month	96	5.5	54	5.3
Once per month	77	4.5	64	6.2
2 to 3 times per month	131	7.6	104	10.1
Once per week	156	9.0	114	11.1
More than once per week	1272	73.4	692	67.3
DPASS SubCohort Who Engage in Sports and Exercise				
Less than once a month	11	7.1	9	20
Once per month	9	5.8	4	3.8
2 to 3 times per month	17	11.0	6	5.7
Once per week	12	7.7	6	5.7
More than once per week	106	68.4	81	76.4

* Excludes respondents (2367 women; 175 men) who indicated they do not play sports or exercise.

time. The responses show a bimodal distribution. More than 40% of men and women indicated they do not walk during leisure time. All together, approximately two thirds of men and women walked once per week or less. The remaining 35%–40% walked more than once per week. Also as shown in Table 2, the prevalence of walking during leisure time as assessed by the PAC for the entire cohort was very similar to that of the DPASS subsample. Table 3 shows responses to the item asking for frequency of sweating from exertion during leisure time. Similar to the observations for the walking item, a bimodal distribution was seen. Approximately half the women and >40% of men reported sweating from exertion during leisure time infrequently–less than once a month. However, approximately one third of men and women reported sweating during leisure time frequently–more than once a week. The pattern of responses indicated that women were somewhat less likely than men to report sweating from exertion during leisure time. The results were similar for the subset of DPASS participants. Finally, we examined responses to an item asking for frequency of playing sports or exercise during the past year. This item excluded the 51% of female and 46% of male respondents who indicated they did not engage in sports or exercise. Table 4 shows responses to this item, indicating that >80% of women and 77% of men who reported being involved in sports and exercise were active at least once per week. Responses were again similar for DPASS participants.

DISCUSSION

While the importance of physical activity to health has become increasingly clear during the past two decades, the measurement of physical activity has remained a challenge for public health research.[34] Health-related physical ac-

tivity includes a wide variety of activities of daily living (bathing, feeding, grooming), household activities, child/adult care, occupational activity, and activities in sport and leisure. The contribution of different types of physical activity to the total varies considerably between individuals and populations. Both direct (eg, questionnaire, diary, mechanical or electronic monitoring) and indirect (eg, dietary, body composition measurement, physiological fitness, sports/recreational participation, occupational classification) methods have been used to assess physical activity in relation to public health in large populations. By enlisting volunteer subsamples, the JHS used several of these methods while minimizing participant burden.

For public health surveys, the most frequent choice for physical activity assessment has been interviews or questionnaires. These are favored because they do not alter the behavior of the person being surveyed, are practical in terms of cost of administration and participant convenience, and can be adapted to the population being assessed.[34] Although subject to considerable measurement error, good survey measures can rank individuals in different population groups from least to most active, and in many epidemiologic studies (eg, Framingham, Honolulu Heart Study, ARIC), physical activity surveys have been able to detect some of the expected inverse relationships between physical activity and coronary heart disease risk.[2–3,16,35]

The initial findings presented here suggest that the JHS participants are similar to recent samples of Mississippi residents by the Behavioral Risk Factor Surveillance Surveys. In 2003, 37.6% of women and 43.4% of men met current guidelines for moderate physical activity (at least 30 minutes of moderate physical activity at least five days per week).[36] The JHS initial analyses showed 30%–40% of participants reported physical activity more than once a week. In these analyses, the DPASS cohort responses were generally similar to those of the full cohort.

In future analyses, each of the physical activity measures used in the JHS will contribute unique information, and the multimethod approach will also allow validation studies of the PAC cohort instrument. The concurrent collection of several types of physical activity information, along with data on diet, body composition, cardiovascular functioning, inflammation, renal function, psychosocial variables, and genetics, will provide a valuable database for investigators to explore interrelationships. The varied characteristics of the cohort and DPASS sample will also allow investigators to go beyond the interracial comparisons that characterize much of the literature and to examine intraracial variability. The physical activity component of the JHS may contribute to significant advances in understanding African-American physical activity and the relationship of physical activity to CVD and other health outcomes.

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REFERENCES

1. Kannel WB. Habitual level of physical activity and risk of coronary heart disease. *CMAJ*. 1967;96:811–812.
2. Kannel WB, Sorlie P. Some health benefits of physical activity: The Framingham Study. *Arch Intern Med*. 1979;139:857–861.
3. Donahue RP, Abbott RD, Reed DM, Yano K. Physical activity and coronary heart disease in middle-aged and elderly men: the Honolulu Heart Program. *Am J Public Health*. 1988;78:683–685.
4. Duncan BB, Chambless LE, Schmidt MI, et al. Correlates of body fat distribution. Variation across categories of race, sex, and body mass in the Atherosclerosis Risk in Communities study. *Ann Epidemiol*. 1995;5:192–200.
5. Brancati FL, Kao WHL, Folsom AR, Watson RL, Szklo M. Incident type 2 diabetes mellitus in African-American and White adults. *JAMA*. 2000;283:2253–2259.
6. Crespo CJ, Smit E, Andersen RE, Carter-Pokras O, Ainsworth BE. Race/ethnicity, social class, and their relation to physical inactivity during leisure time: results from the Third National Health and Nutrition Examination Survey, 1988–1994. *Am J Prev Med*. 2000;18:46–53.
7. Liao Y, Tucker P, Okoro CA, Giles WH, Mokdad AH, Harris VB. REACH 2010: surveillance for health status in minority communities. United States, 2001–2002. *MMWR Surveill Summ*. 2004;27:531–536.
8. Pratt M, Macera CA, Blanton C. Levels of physical activity and inactivity in children and adults in the United States: current evidence and research issues. *Med Sci Sports Exerc*. 1999;31:S526–S533.
9. Centers for Disease Control and Prevention. State-specific prevalence of selected health behaviors by race and ethnicity–Behavioral Risk Factor Surveillance System, 1997. *Morb Mortal Wkly Rep*. March 2000;49:1.
10. Adams-Campbell LL, Rosenberg L, Washburn RA, Rao RS, Kim KS, Palmer J. Descriptive epidemiology of physical activity in African-American women. *Prev Med*. 2000;30:43–50.
11. Whitt M, Kumanyika S, Bellamy S. Amount and bouts of physical activity in a sample of African-American Women. *Med Sci Sports Exerc*. 2003;35:1887–1893.
12. Flegal KM, Carroll MD, Ogden MD, Johnson CL. Prevalence and trends in obesity among US adults, 1999–2000. *JAMA*. 2002;288:1723–1727.
13. Mokdad AH, Ford ES, Bowman BA, et al. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA*. 2003;289:76–79.
14. Bassett DR Jr, Fitzhugh EC, Crespo CJ, King GA, McLaughlin JE. Physical activity and ethnic differences in hypertension prevalence in the United States. *Prev Med*. 2002;34:179–186.
15. Harris MI, Goldstein DE, Flegal KM, et al. Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in US adults. *Diabetes Care*. 1998;21:518–524.
16. Folsom AR, Arnett DK, Hutchinson RG, Liao F, Clegg LX, Cooper LS. Physical activity and

incidence of coronary heart disease in middle-aged women and men. *Med Sci Sports Exerc*. 1997;29:901–909.
17. Pereira MA, Folsom AR, McGovern PG, et al. Physical activity and incident hypertension in Black and White adults: the Atherosclerosis Risk in Communities study. *Prev Med*. 1999;28(3):304–312.
18. Baecke JAH, Burema J, Fritjers JER. A short questionnaire for the measurement of habitual activity in epidemiological studies. *Am J Clin Nutr*. 1982;36:936–942.
19. Richardson MT, Ainsworth BE, Wu H, Jacobs DR Jr, Leon AS. Ability of the Atherosclerosis Risk in Communities (ARIC)/Baecke Questionnaire to assess leisure-time physical activity. *Int J Epidemiol*. 1995;24:685–693.
20. Ainsworth BE, Sternfeld B, Richardson MT, Jackson K. Evaluation of the Kaiser Physical Activity Survey in women. *Med Sci Sports Exerc*. 2000;32:1327–1338.
21. Sternfeld B, Ainsworth BE, Quesenberry CP. Physical activity patterns in a diverse population of women. *Prev Med*. 1999;28:313–323.
22. Paffenbarger RS, Wing AL, Hyde RT. Physical activity as an index of heart attack risk in college alumni. *Am J Epidemiol*. 1978;108: 161–175.
23. Paffenbarger RS, Blair SN, Lee I, Hyde RT. Measurement of physical activity to assess health effects in free-living populations. *Med Sci Sports Exerc*. 1993;25:60–70.
24. Ainsworth BE, Haskell WL, Whitt MC, et al. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc*. 2000;32:S498–S516.
25. Freedson PS, Melanson E, Sirard J. Calibration of the Computer Science and Applications, Inc. accelerometer. *Med Sci Sports Exerc*. 1998;30:777–781.
26. Trost SG, Ward DS, Burke JR. Validity of the Computer Science and Application (CSA) activity monitor in children. *Med Sci Sports Exerc*. 1998;30:695–633.
27. Bassett DR Jr, Ainsworth BE, Swartz AM, Strath SJ, O'Brien KO, King GA. Validity of four motion sensors in measuring moderate intensity physical activity. *Med Sci Sports Exerc*. 2000;32:S471–S480.
28. Hendelman D, Miller K, Baggett C, DeBold E, Freedson P. Validity of accelerometry for the assessment of moderate intensity physical activity in the field. *Med Sci Sports Exerc*. 2000;32:S442–S449.
29. Sirard JR, Melanson EL, Freedson PS. Field evaluation of the Computer Science and Applications, Inc. physical activity monitor. *Med Sci Sports Exerc*. 2000;32:695–700.
30. Ainsworth BE, Bassett DR Jr, Scott SJ, et al. Comparison of three methods for measuring the time spent in physical activity. *Med Sci Sports Exerc*. 2000;32:S457–S464.
31. Washburn RA, Heath GW, Jackson AW. Reliability and validity issues concerning large-scale surveillance of physical activity. *Res Q Exerc Sport*. 2000;71:104–113.
32. Tudor-Locke C, Bassett DR Jr. How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Med*. 2004; 34:1–8.
33. Bassett DR Jr, Ainsworth BE, Legget SR, et al. Accuracy of five electronic pedometers for measuring distance walked. *Med Sci Sports Exerc*. 1996;28:1071–1077.
34. Kriska AM, Caspersen CJ. Introduction to a collection of physical activity questionnaires. *Med Sci Sports Exerc*. 1997;29:s5–s9.
35. Hakim AA, Curb JD, Petrovitch H, et al. Effects of walking on coronary heart disease in elderly men [abstract]. *Circulation*. 1999; 100:9–13.
36. Centers for Disease Control and Prevention. Prevalence of physical activity, including lifestyle activities among adults–United States, 2000–2001. *Morb Mortal Wkly Rep*. 2003; 52:764–769.