VALIDATION OF PHYSICAL ACTIVITY INSTRUMENTS: BLACK WOMEN'S HEALTH STUDY

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Purpose: Few studies have reported on the validity of physical activity measures in African Americans. The present study was designed to determine the validity of a self-administered physical activity questionnaire (PAQ) that was used in a large prospective study of African American women in the United States against an accelerometer (actigraph), an objective assessment of movement, and a seven-day activity diary.

Methods: The study was conducted among 101 women enrolled in the Black Women's Health Study (BWHS) cohort who resided in the Washington, DC, metropolitan area, representing 11.2% (101/900) of this sample. Physical activity levels were obtained from the parent BWHS PAQ (eg, 1997 and 1999) and repeated in the present study. This information entailed hours per week of participation in walking for exercise, hours per week of moderate activity (eg, housework, gardening, and bowling), and hours per week of strenuous activity (eg, basketball, swimming, running, and aerobics) during the previous year. The participants were required to wear actigraphs for seven days and then record their physical activities in their diaries (seven-day physical activity diary) during this time. The diaries were used to record the amount and pattern of daily energy expenditure.

Results: Significant positive correlations were seen between the BWHS PAQ and the actigraph for total activity, $r=.28$; walking, $r=.26$; and vigorous activity, $r=.40$, $P<.001$. For the seven-day physical activity diary, the BWHS PAQ also demonstrated significant correlations for total ($r=0.42$, $P<.01$); moderate ($r=.26$, $P<.05$); and vigorous activities ($r=.41$, $P<.01$).

Conclusions: The BWHS PAQ is a useful measure of physical activity in the BWHS cohort and thus has utility in prospective epidemiologic research. (*Ethn Dis*. 2006;16:943–947)

Key Words: Accelerometers, African Americans, Physical Activity, Validation, Women

INTRODUCTION

Valid methods must be used to assess physical activity patterns to accurately evaluate epidemiologic/surveillance studies as well as intervention programs. Most physical activity assessment instruments have been validated by correlating self-reported behavior with physiologic criteria, including cardiovascular fitness, adiposity, heart rate or blood pressure, or other objective measures of physical activity such as accelerometers.[1–5] Numerous physical activity measures have been validated in White adults.[1–4] However, reported studies of the validity of physical activity measures in African Americans[5,6] have been limited. Whether African Americans have different perceptions and health behaviors that may influence the response to physical activity instruments is not known.[7–9] Young et al,[10] suggest that the validity of physical activity measures vary by ethnicity; therefore, the validation of activity instruments among African Americans is warranted.

Self-reported measures of physical activity and indices of cardiorespiratory fitness vary tremendously, with correlation coefficients ranging from .11 to .76. However, the stronger correlations have been demonstrated between physical activity and physiologic indices such as blood pressure and cardiorespiratory fitness, among moderate and vigorous activities.[1–4,6,11,12] Singh et al[6] have reported similar findings in African American women.

The present study was designed to determine the validity of a self-administered physical activity questionnaire that was used in a large prospective study of African American women in the United States.[13] More specifically, the Black Women's Health Study (BWHS) self-report physical activity questionnaire (PAQ) was validated against an accelerometer (actigraph), an objective assessment of movement, and against events recorded in a seven-day activity diary.[14]

METHODS

Study Participants

The study was conducted among a subset of women enrolled in the BWHS cohort who resided in the Washington, DC, metropolitan area. The BWHS is a follow-up study in African American women aged 21 to 69 years who enrolled in the study in 1995 by completing mailed health questionnaires.[15] The women were followed through biennial mail health questionnaires. Women were eligible for the present study if they met the

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following criteria: 1) resided in the Washington, DC, metropolitan area; 2) completed the BWHS physical activity questions on the 1997 and 1999 follow-up questionnaires; 3) were ambulatory; 4) had no surgery within the past three months; and 5) had no medical history of cancer. More than 11% (101/900) of the sample participated in the validation study.

Study Procedures

Once identified, the eligible women were contacted by telephone and invited to the epidemiology clinic located at the Howard University Cancer Center. The women agreed to attend two clinic visits, totaling one and a half hours and wear the activity monitor for seven days. The initial clinic visit included presentation of the consent form, clinical measurements, and completion of survey instruments. The follow-up clinic visit entailed the return of the activity diary and the actigraph, as well as discussion regarding issues or concerns with the diary and equipment.

Anthropometric Measurements

Measures were obtained of height, weight, blood pressure, and heart rate. Weight was measured with the participant clothed (lightly), without shoes, to the nearest .1 kg. Height was measured in inches by using a mounted stadiometer. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2).

Survey Instruments

Epidemiologic Data. The epidemiologic questionnaire assessed sociodemographic characteristics: age, education, marital status, income, type of employment, and menstrual and reproductive, medical, family (eg, various health conditions), and tobacco history. The questions administered about physical activity were the same questions as those from the parent BWHS study (eg, 1997 and 1999). This information entailed hours per week of participation in walking for exercise, hours per week of moderate activity (eg, housework, gardening, and bowling) and hours per week of strenuous activity (eg, basketball, swimming, running, and aerobics) during the previous year. The response categories for each question were none, <1, 1, 2, 3–4, 5–6, 7–9, and 10 or more hours.[13]

Activity Diary. At the end of the clinic visit, participants were given activity diaries[14] with detailed instructions. During the seven days that the women wore the actigraphs, activity diaries were used to record the amount and pattern of daily energy expenditure. The previously validated diary is designed to record 15-minute intervals. The 15-minute intervals are quantified in terms of energy cost on a one to nine scale.[14]

Activity Monitor. Along with the activity diary, each woman received an actigraph, with detailed instructions, to record her activity for seven days. The actigraph used was the Computer Science and Applications Model 7164 (version AM7164-2.2). The actigraph is a uniaxial accelerometer designed to assess and record accelerations ranging in magnitude from .05 to 2.0 g and is an ultra-compact, lightweight, electronic activity monitor that is bond-limited with a frequency response between .25 to 2.5 Hz. The noted parameters allow the ability to detect normal human motion and reject movement from other sources. The acceleration signal is filtered by an analog bandpass filter and digitized by an eight-bit analog-to-digital converter at 10 samples per second.[16] Each digitized signal is summed over a user-specific interval of time (eg, epoch) and stored in a memory bank internally. The numerical integrator is then reset to zero. An epoch may be categorized as one second to several minutes. For the current study, the data were collected in one-minute epochs, and activity counts obtained were expressed as the averages per minute over the seven-day period.

Each actigraph was initialized, according to the manufacturer's specifications, to begin recording daily activity starting at 5 AM the morning after the clinic visit. The activity monitor was to be worn all day (morning until bedtime) for seven consecutive days. The activity monitor was not to be worn during sleep or bedtime, while in the bath or shower, and during any water activities or sports (eg, swimming, water aerobics).

Calculation of METs

For the variables from the BWHS pertaining to hours per day, the amount of physical activity per day was multiplied by seven to get a total amount of hours per week. The metabolic equivalents (METs) were assigned for strenuous activity, walking for exercise, and moderate activity as 7, 3.5, and 3 METs, respectively.[2] A total physical activity variable (MET–hours per week) was created by multiplying the assigned MET value (for each specific activity) by the hours exercised per week, then summing the values for all the types of activity. Appendix A describes the physical activities ranked by MET value.

Statistical Analysis

Selected sample characteristics were summarized by using means and standard deviations for the study population. Medians and interquartile ranges were calculated for weekly self-reported PAQ variables, total activity, walking for exercise, moderate activity, and vigorous activity, all in METs/week. The same measures were computed for total weekly counts (using the actigraph) and activity diary. To evaluate the validity of the BWHS PAQ, we computed Spearman rank correlation coefficients (and the corresponding confidence intervals) between the weekly self-reported PAQ scores on total activity,

Table 1. Selected characteristics of the Black Women's Health Study

Variable	Median	Total (n=101) Mean ± SD	Interquartile Range
Age (years)	48.0	49.5 ± 10.7	42.0–57.0
Weight (kg)	78.6	81.9 ± 20.7	65.6–94.6
Height (m)	1.6	1.6 ± .07	1.5–1.7
BMI (kg/m^2)	29.6	30.9 ± 7.5	24.6–36.3

SD= standard deviation; BMI= body mass index.

walking for exercise, moderate activity, and vigorous activity; the actigraph scores (total weekly counts); and the activity diary scores. Further assessment of the validity of the PAQ was accomplished by determining Spearman rank correlation coefficients between PAQ scores and physiologic measures (systolic blood pressure [SBP], diastolic blood pressure [DBP], and heart rate). Tests were considered significant whenever *P* values were<.05, and all analyses were done with SPSS version 10.1 for Windows (SPSS Inc., Chicago, Ill).

RESULTS

The study comprised 101 African American women with a median age of 48.0 years. The anthropometric measures are shown in Table 1. The median BMI of the study population was 29.6 kg/m^2. Medians and interquartile ranges for the BWHS PAQ, actigraph, and seven-day physical activity diary are presented in Table 2.

Spearman rank correlation coefficients for the BWHS PAQ, actigraph, and activity diary are shown in Table 3. Significant positive correlations were seen between the BWHS PAQ and the actigraph for total activity, r=.28; walking, r=.26; and vigorous activity, r=.40, P<.001. In comparison with the diary, the BWHS PAQ also demonstrated significant correlations for total activity and moderate and vigorous activities.

Depicted in Table 4 are the correlations between the BWHS PAQ and selected physiologic variables. The findings revealed significant negative correlations between vigorous activity and systolic and diastolic blood pressure, which is the expected direction.

Table 2. Medians and interquartile ranges for BWHS PAQ and 7-day PA diary (MET-hours/week), *n*=101

Variable	Median	Interquartile Range
BWHS Survey (MET-hours/week)		
Total activities	57.8	36.8–99.8
Walking	12.3	12.3–24.5
Moderate activity	21.0	21.0–73.5
Vigorous activity	7.0	0.0–24.5
7-day PA diary (MET-hours/week)		
Total activity	25.5	24.2–27.4
Moderate activity	3.9	1.8–7.0
Vigorous activity	0.0	0.0–1.4

BWHS=Black Women's Health Study; PAQ=physical activity questionnaire; PA=physical activity; MET=metabolic equivalent task.

Table 3. Spearman rank correlation coefficients for BWHS PAQ, actigraph and 7-day PA diary

		Correlation Coefficient, *r* 7-Day PA Diary		
	Actigraph	Total Activity	Moderate Activity	Vigorous
Total (*n*=101)				
BWHS PAQ (MET-hour/week)				
Total activities	.28†	.32†		
Walking	.26†			
Moderate activity	−.04		.26*	
Vigorous activity	.40†			.41†

* Correlation is significant at the .05 level (two-sided).
† Correlation is significant at the .01 level (two-sided).
BWHS=Black Women's Health Study; PAQ=physical activity questionnaire; PA=physical activity; MET=metabolic equivalent task.

DISCUSSION

The ability to classify participants accurately according to activity levels is the primary objective of physical activity assessment in epidemiologic studies. In the present study, significant rank-order correlations between the BWHS PAQ and the actigraph for total, walking, and vigorous activities were demonstrated. These findings suggest that the instrument was able to provide reasonable stratification of the cohort by level of frequency and duration. The seven-day physical activity diary revealed significant positive correlations with the BWHS PAQ for total, moderate, and vigorous activities. Correlations were strongest for vigorous activity; the moderate activity category was only correlated between the BWHS PAQ and the activity diary and not the actigraph. Furthermore, the validity coefficients for the activity diary were consistently higher than those for the actigraph, which may be attributed to

Table 4. Spearman rank correlation coefficients between the BWHS PAQ and selected physiologic variables

Variable	BWHS Survey METs			
	Total Activities	Walking for Exercise	Moderate Activity	Vigorous Activity
Total (*N*=101)				
SBP (mm Hg)	−.02	.01	.12	−.24*
DBP (mm Hg)	−.002	.10	.13	−.29*
Heart rate (bpm)	−.09	−.11	.003	−.13

* $P<.05$.

BWHS=Black Women's Health Study; PAQ=physical activity questionnaire; MET=metabolic equivalent task; SBP=systolic blood pressure; DBP=diastolic blood pressure.

the greater similarities in question structure and content between the seven-day physical activity and the BWHS PAQ. The stronger results for the seven-day physical activity comparisons may have been due to the fact that the correlations attributable to intraindividual variation in activity were minimized. In addition, the correlations for the actigraph were with all movement, whereas those for the diaries were with moderate and vigorous activity that had been abstracted from the various activities recorded in the diaries.

The study had a number of limitations that must be considered when interpreting this report. In determining the validity of self-reported physical activity levels, no easily administered gold standard is available to measure overall activity and individual activity domains (eg, exercise, household, transportation) that would allow true validation of the instrument. The BWHS PAQ evaluated physical activity patterns over a one-year period, and it is subject to errors of recall attributable to memory. Previous validation studies of instruments used in prospective research have reported results that are consistent with current findings.[1–6] Overall, the findings support the BWHS PAQ as a useful measure of physical activity exposures in this cohort. Thus, the PAQ has utility in prospective, epidemiologic research in the BWHS on the influence of physical activity on disease occurrence.

These findings suggest that the instrument [the PAQ] was able to provide reasonable stratification of the cohort by level of frequency and duration.

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AUTHOR CONTRIBUTIONS

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Supervision: Carter-Nolan, Adams-Campbell, Rosenberg

APPENDIX 1. Physical activities ranked by met value

MET value = <3.0: resting or light (eg, watching television, reading, etc)
MET value = 3.0: moderate exercise (eg, housework, gardening, bowling, etc)
MET value = 3.5: walking for exercise
MET value = 7.0: vigorous/strenuous (eg, basketball, swimming, running, aerobics, etc)

MET=metabolic equivalent task.