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Comparing Multiple Measures of Physical Activity in African-American Adults

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Abstract

Objectives: We assessed the agreement between self-reported and accelerometer-assessed physical activity (PA) in African-American adults by sex, education, income, and weight status.

Methods: Participants (N = 274) completed the International PA Questionnaire short form (IPAQ-S), Behavioral Risk Factor Surveillance System (BRFSS) PA questions, and PA Questionnaire (PAQ) and a 7-day accelerometer protocol using a waist-worn ActiGraph GT3X accelerometer. Interrelationships among PA measures were assessed by sociodemographics.

Results: Participants consistently reported doing 150 minutes of moderate-to-vigorous-intensity PA (MVPA) per week via self-report measures and did 113.5±179.4 minutes of accelerometer-assessed MVPA/week. Men self-reported and did more MVPA than women ($p < .01$). Regardless

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Conflict of Interest Statement

Authors have no conflicts of interests to disclose.

of sex, there were low correlations between self-report and accelerometer-assessed MVPA ($r = .092-.190$). Poor agreement existed between self-report and accelerometry for classifying participants as meeting PA recommendations (Cohen $k = .054-.136$); only half of the participants were classified the same by both self-report and accelerometry.

Conclusions: There was generally poor relative agreement between self-report and accelerometer-based assessments of MVPA in this sample of African-American adults. Findings suggest that self-report measures may perform better among African-American women than men, regardless of socioeconomic or weight status.

Keywords

exercise; accelerometry; measurement; minority health; adult

Physical inactivity or low physical activity and overweight/obesity account for nearly one-fourth of deaths in the United States (US),¹ and an estimated \$131 billion of healthcare expenditures per year are associated with inadequate levels of physical activity.² Physical inactivity, sedentary behaviors and obesity increase the prevalence of non-communicable diseases, such as heart disease and cancer, the 2 leading causes of death in the US.³ Despite substantial increases in leisure-time physical activity over the past 20 years, African-American adults remain less likely than non-Hispanic white adults to meet federal physical activity guidelines for aerobic activity (44.4% vs 56.2% active, respectively),⁴ contributing to health disparities related to physical inactivity and obesity.^{5,6} Although intervention strategies exist to increase physical activity in high risk, underserved populations,^{7,8} African-American adults in the US remain insufficiently active.⁹

Physical activity promotion efforts are hampered by inconsistencies and inaccuracies in the measurement of physical activity, which leads to the misclassification of physical activity habits.¹⁰⁻¹² For example, over-reporting physical activity on self-report measures may lead to the incorrect classification of respondents as meeting federal physical activity guidelines of 150 minutes of moderate-to-vigorous-intensity physical activity (MVPA) per week,¹⁰ thus excluding them from health promotion efforts aimed at insufficiently active individuals.¹³ Self-reported physical activity is typically measured by a series of questions that identify frequency and duration of engagement in activities,¹⁴ but these instruments have been validated mostly in Caucasian males and other samples not representative of the US population.¹⁵⁻¹⁸ In 2008, Wolin et al¹¹ examined the validity of the International Physical Activity Questionnaire-Short (IPAQ-S) in a sample of low-income black adults. They found moderate agreement between self-reported and accelerometer-assessed physical activity overall, and weaker agreement in women,¹¹ questioning the performance of self-reported physical activity measures in diverse populations.

Objective measures of physical activity, like accelerometry, are widely regarded as the criterion of physical activity measurement, but are not used commonly in national or large-scale epidemiologic studies.¹⁹ The National Health and Nutrition Examination Survey (NHANES) included accelerometry in the 2003–2004 and 2005–2006 assessment cycles, providing the first nationally representative sample of objectively measured physical activity data.^{14,20} Using these data, Ham and Ainsworth found sociodemographic disparities in

physical activity in addition to disparities between self-report and accelerometer-assessed physical activity, supporting the use of both self-reported surveys *and* accelerometry for physical activity surveillance and research.²⁰

Previous studies suggest differences in correlations between self-reported and accelerometer-assessed physical activity in adults by sex, weight status, and age,²¹ and socioeconomic status may contribute further to disagreements between assessments.¹¹ Yet, the vast majority of studies comparing self-reported and objectively measured physical activity have not included large enough samples of African-American adults to explore differences in measure performance by sex and sociodemographic characteristics.^{10,11,22,23} Moreover, these studies do not consistently use the same instrument to assess self-reported physical activity, making it difficult to draw comparisons between measures and studies. Thus, the goals of the current study were to: (1) compare 3 widely used self-report physical activity questionnaires (the IPAQ-S, the Behavioral Risk Factor Surveillance System [BRFSS] physical activity questions, and the Physical Activity Questionnaire [PAQ]) and accelerometry on the measurement of MVPA in a large sample of African-American adults; and (2) determine whether differences in self-reported and accelerometer-assessed MVPA varied by sociodemographic characteristics, including sex, education, income and weight status.

METHODS

Study Design

Data were used from Project CHURCH (Creating a Higher Understanding of Cancer Research and Community Health), a longitudinal cohort study designed to examine the role of lifestyle/ behavioral, social, and environmental factors on health and cancer-related disparities in a sample of African Americans in Houston, Texas. Project CHURCH study details have been published previously but are described briefly below.²⁴ For this cross-sectional study, questionnaire and physical assessment data collected in year 3 of the study were used to examine the relationship between self-reported and accelerometer-assessed MVPA.

Sample and Procedures

African-American men and women were recruited to Project CHURCH between January and December 2011. Eligible persons were at least 18 years old, were English speakers, had a valid home address and telephone number, and attended church services at a partner church in the Houston metropolitan area. Participants completed an in-person assessment at the church, which included anthropometric measurements and a computer-based survey to assess sociodemographic characteristics and self-reported physical activity. The complete assessment took up to 90 minutes; participants were compensated for study completion, and they were provided with health promotion information on physical activity adoption, improving dietary habits, and smoking cessation.

Upon completion of the in-person assessment, an optional accelerometer assessment was offered to the first 500 persons who expressed interest. Participants were instructed to wear

the accelerometer device above their right hipbone for 7 consecutive days. They were instructed to wear the accelerometer for at least 12 hours each day, except when sleeping, swimming, showering or bathing. They were also instructed to self-report their average weekly physical activity over the past year on the PAQ. Accelerometers and completed PAQs were returned in person at the church or by mail in a provided self-addressed stamped envelope after 7 days. Accelerometer data were downloaded, processed, and analyzed as described below.

Overall, 1400 men and women participated in year 3 of Project CHURCH, and 86.8% (N = 434 out of 500) of those who were offered participation completed the optional accelerometer assessment. Among persons who completed the accelerometer assessment, 87.3% had valid accelerometer data. The final sample for analysis included 274 participants with complete accelerometer, self-reported physical activity questionnaire, and BMI data.

Measures

Sociodemographics.—Sociodemographics included sex, age, education, and annual household income, and measured height and weight were used to compute body mass index ($BMI = kg/m^2$). Educational attainment was categorized as 1 = less than a bachelor's degree, 2 = a bachelor's degree, or 3 = a master's degree or more. Income status was categorized as an annual household income of 1 = <\$40,000, 2 = \$40,000–79,999, or 3 = \$80,000. Weight status was categorized as 1 = underweight or normal weight ($BMI < 25.0 kg/m^2$), 2 = overweight ($BMI = 25.0–29.9 kg/m^2$), and 3 = obese ($BMI \geq 30.0 kg/m^2$). Category schemes were chosen to match those previously reported from Project CHURCH.²⁴

Self-reported physical activity.—Self-reported physical activity was assessed using the IPAQ-S, BRFSS physical activity questions, and the PAQ. The IPAQ-S assesses vigorous- and moderate-intensity physical activity, walking, and total physical activity over the past 7 days; it has been used widely and validated for population surveillance of physical activity in diverse populations.^{25–28} The BRFSS physical activity questions assess moderate- and vigorous-intensity physical activity completed in at least 10-minute bouts in a usual week. The reliability and validity of the BRFSS physical activity questions suggest it is appropriate for classifying adults' physical activity status.^{29,30} Similar to the BRFSS, the PAQ assesses average time per week spent engaging in recreational physical activity over the past year via one item ("During the past year, what was your average time per week spent at each of the following recreational activities?") and has been widely used and validated for population surveillance of physical activity.³¹

Physical activity was reported in hours and/or minutes per day and days per week across measures, and the total number of minutes of MVPA per week was used in analyses.

Objectively-assessed physical activity.—ActiGraph GT3X accelerometers (The ActiGraph, LLC, Pensacola, FL) were used to objectively measure physical activity. ActiGraph accelerometers have exhibited strong associations between activity counts and measured energy expenditure, are responsive to different intensities of physical activity, and have the lowest amount of variance across activity monitors, indicating strong validity and reliability.³² Accelerometers recorded data over a 7-day period using a 10-second epoch.

The criterion for including accelerometer data in analyses was ≥ 3 days of valid wear, which was defined as ≥ 10 hours of valid wear time.^{33,34} Valid wear time was determined by subtracting non-wear time, defined as ≥ 20 minutes of consecutive zero counts, from 24 hours. Persons without ≥ 3 valid days of data were not included in analyses; invalid days were not included in analyses. Raw activity counts were converted to minutes spent doing MVPA using an established cut point for adults³⁵ and determined using a 10-minute bout length, which only includes minutes of MVPA that occurred in bouts of ≥ 10 consecutive minutes, to be consistent with self-reported IPAQ-S, BRFSS, and PAQ physical activity data.

Data Analysis

Mean, median, standard deviation, and interquartile range (IQR) were calculated for questionnaire-and accelerometer-assessed MVPA minutes per day. Because of the skewed distribution of the physical activity data, a non-parametric bootstrapping procedure using 5000 resamples from the dataset was used to test effects. Unadjusted and adjusted (adjusting for age, sex, education, income, and weight status) Pearson correlation coefficients with 95% confidence intervals (CI) were calculated to determine the correlation between questionnaire-and accelerometer-measured MVPA minutes per day. We used Bland-Altman plots to compare the differences in questionnaire-and accelerometer-assessed MVPA minutes per day. Cohen's κ coefficients with 95% CI were calculated to determine the agreement between questionnaire-and accelerometer-measured MVPA minutes per day and the agreement between measures for classifying participants as having met aerobic physical activity guidelines of ≥ 150 minutes of MVPA per week. Generally, Pearson correlation and Cohen's κ coefficients <0.10 were interpreted as negligible correlation, 0.10–0.39 as weak, 0.40–0.69 as moderate, and ≥ 0.70 as strong or very strong.³⁶ All statistical analyses were conducted using SPSS 24.0 (IBM SPSS Statistics, Armonk, NY), and a p-value of .05 was used as the criterion for all statistical testing.

RESULTS

Table 1 presents the sample characteristics.

Table 2 lists mean and median questionnaire-and accelerometer-measured MVPA minutes per day for the total sample by instrument and by sex, education, income and weight status, and highlights the mean difference between self-reported (IPAQ-S, BRFSS, and PAQ) and accelerometer-assessed MVPA. Self-reported MVPA on the IPAQ-S ($t = 2.169$, $p = .031$) and BRFSS ($t = 2.991$, $p = .003$) was significantly higher among men than among women. There were no other statistically significant differences between questionnaire-and accelerometer-assessed MVPA by education, income, or weight status.

Table 3 lists Pearson correlation coefficients between questionnaire-and accelerometer-measured MVPA minutes per day. After adjusting for age, sex, education, and income and weight status, we found statistically significant correlations were only between the IPAQ-S and accelerometer-assessed MVPA minutes per day. The Bland-Altman plots in Figure 1 show a systematic over-reporting of IPAQ-S (Panel A), BRFSS (Panel B), and PAQ (Panel C) MVPA minutes per week when compared with accelerometry. The solid horizontal lines indicate the relative bias (mean difference) and the dashed lines represent the 95% limits of

agreement. The differences are not evenly distributed between the limits of agreement, indicating systematic bias.

The Cohen's κ coefficients listed in Table 4 further demonstrate the poor agreement among IPAQ-S, BRFSS, and PAQ questionnaires and accelerometer-assessed MVPA minutes per day for classifying persons as having met aerobic physical activity guidelines of at least 150 minutes of MVPA per week. Crosstabs showed that 47.5% of participants were classified the same by both the IPAQ-S and accelerometry; 48.2% were classified the same by both the BRFSS and accelerometry; and 50.0% were classified the same by both the PAQ and accelerometry.

DISCUSSION

Among African-American adults, low to non-significant agreement was found between self-reported and accelerometer-assessed MVPA minutes per week, with correlations varying by sociodemographics, particularly sex. In addition, low agreement was observed between self-report and accelerometry in the classification of individuals as meeting (17.2%–20.8%) or not meeting (28.1%–30.3%) federal physical activity guidelines for aerobic exercise.³⁷ Findings suggest that the IPAQ-S, BRFSS physical activity questions, and the PAQ are not acceptable for measuring physical activity in this sample of African-American men and women.

Consistent with previous validation studies of self-reported physical activity questionnaires in diverse populations, both men and women overestimated their physical activity.^{15,16,26,38} MVPA measured via the IPAQ-S, BRFSS, and PAQ were 215%–382% higher than accelerometer-measured MVPA in the current study, which is higher than the percent disagreement typically seen among non-Hispanic white adults.^{15,26} Disagreements between self-reported and accelerometer-assessed MVPA may be due to the types of questions included and activities assessed via brief self-report questionnaires. The IPAQ-S, BRFSS, and PAQ ask questions regarding moderate-and vigorous-intensity physical activity and recreational activities and may not accurately capture other lifestyle behaviors, such as occupational or domestic and household activities.^{13,21} Additionally, accelerometers may not capture of all physical activities that African-American men and women engage in, such as strength training, cycling, yoga or tai-chi, or dancing,^{21,39–41} further contributing to disagreements between self-reported and accelerometer-assessed physical activity in this study.

African-American men in the current study engaged in more MVPA per week than did women across all measures with the exception of the PAQ. Although both men and women tended to over-estimate their physical activity, African-American men over-reported their MVPA on the IPAQ-S and BRFSS to a larger extent than did African-American women, which is contrary to what Wolin et al¹¹ found when validating the IPAQ-S among low-income African-American men and women. Other studies have found that sex differences contribute to how well self-report instruments perform and have suggested that socioeconomic status may also contribute to this difference.¹¹ However, we found no

statistically significant differences in self-reported and accelerometer-assessed MVPA by education or income in our sample.

Despite over-reporting, we found the IPAQ-S and BRFSS questionnaires were more strongly correlated with accelerometry and performed better after controlling for age and poorer after adjusting for sex. This is consistent with previous studies, showing greater correlation between the IPAQ-S and accelerometer-measured physical activity.²¹ Unlike the BRFSS and PAQ, the IPAQ-S asks individuals to consider activities done as part of work, house and yard work, and to get from place to place in addition to leisure-time or recreational activities, which may contribute to stronger correlations between the IPAQ-S and accelerometer-assessed MVPA. Previous studies have examined sex differences in the performance of self-reported measures of physical activity,^{11,38,42} but few have explored additional sociodemographic differences, which is a significant scientific contribution of this study.^{10,12} Similar to previous validation studies,^{10,11} our results demonstrate the challenges of measuring physical activity using self-report questionnaires and suggest the need to consider sex, education, income, and weight status when evaluating the performance of these measures, particularly for African-American adults.

Strengths of this study include a large sample of African-American adults, a group in which the accuracy of physical activity questionnaires has not been fully explored. Accelerometry is often limited to small or lab-based samples due to cost and time constraints. Previous validation studies using accelerometry in African Americans have included sample sizes between 100 and 150,^{11,12,43} with the exception of the Jackson Heart Study.⁴⁴ Another strength of this study is the use of multiple widely-used self-reported physical activity questionnaires, which allows for comparisons between our sample and a broader representation of other African-American and Caucasian populations.

Limitations of the current study include the modest number of African-American men. Although we were able to explore associations between measures by sociodemographic categories, smaller sub-sample sizes and discordance in sample size across sociodemographic strata may limit the generalizability of findings. Results may also vary if alternative accelerometer bout lengths (eg, one and 10 minutes MVPA bout criteria) and cut-points were used and if light-intensity physical activity versus MVPA were assessed. However, the cut-point used in the current study has been validated for assessing MVPA in adults and is similar, if not identical, to cut-points used in previous studies in African Americans.^{26,35} Although self-reported IPAQ-S, BRFSS, and PAQ questionnaires and accelerometers measured physical activity over a 7-day period, not all measures overlapped or measured the same 7-day period or week. The BRFSS and PAQ assessed physical activity during a usual week. The IPAQ-S assessed physical activity completed during the week prior to participants' in-person assessment, and accelerometers were used to assess physical activity completed during the week after participants' in-person assessments. However, all measures represent habitual physical activity in free-living adults, and the lack of overlap in measurement periods in the current study is consistent with previous studies that have similarly explored differences between physical activity measures and instruments.^{26–28,35,45} Nevertheless, future research should calibrate the timing of assessments more carefully and also consider more fine grained measures (eg, daily) to examine whether doing so might

improve the performance of self-report measures and to assess individual-level agreement between assessment methods. Finally, our population was of relatively high socioeconomic status, further limiting generalizability of findings to African Americans with lower education or income.

Findings suggest that the physical activity self-report questionnaires used in the current study performed poorly among African Americans, and that there are greater differences in self-reported and accelerometer-assessed physical activity among African Americans than non-Hispanic Whites.²⁵ Among African Americans, the IPAQ-S and BRFSS may perform better in some subgroups than others, particularly women. Additional work is needed to enhance the validity of self-report measures among African Americans to assess physical activity more accurately in this population. Reduced inconsistencies in the measurement of physical activity can aid the direction of intervention efforts at specific subpopulations, leading to greater benefits for those who have the most to gain from physical activity promotion efforts and reducing health disparities among African-American adults.

Human Subjects Statement

Project CHURCH study procedures and materials were reviewed and approved by the Institutional Review Board at The University of Texas MD Anderson Cancer Center (Protocol ID: 2007–0970), and all participants provided written informed consent prior to engaging in study activities.

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Figure 1. Bland-Altman Plot of (A) IPAQ-S, (B) BRFSS, and (C) PAQ versus Accelerometer-measured MVPA Per Week

Note.

Solid line represents mean difference line, and dotted lines represent 95% confidence interval. Values above the solid line suggest a systematic over-reporting in MVPA on self-reported questionnaires (IPAQ-S, BRFSS, and PAQ) compared with accelerometry.

Table 1

Sample Characteristics (N = 274)

Sample characteristic	Mean (SD)
Age (years)	51.1 (11.5)
BMI (kg/m ²)	30.8 (6.5)
N (%)	
Sex	
Male	59 (21.5)
Female	215 (78.5)
Education	
< Bachelor's degree	117 (42.7)
Bachelor's degree	91 (33.2)
> Bachelor's degree	66 (24.1)
Annual household income	
< \$40,000	63 (23.0)
\$40,000–79,999	110 (40.1)
\$80,000	101 (36.9)
Weight status	
Underweight or normal weight (BMI < 25.0 kg/m ²)	44 (16.1)
Overweight (BMI 25.0–29.9 kg/m ²)	96 (35.0)
Obese (BMI ≥ 30.0 kg/m ²)	134 (48.9)

Table 2
Mean MVPA per Day and Mean Differences between Accelerometer-assessed and Self-reported MVPA by Instrument and Demographic Variables

	IPAQ-S			BRFSS			PAQ			Accelerometer			Mean difference (SD)		
	Mean (SD)	Median (IQR)		Mean (SD)	Median (IQR)		Mean (SD)	Median (IQR)		Mean (SD)	Median (IQR)		IPAQ-S	BRFSS	PAQ
Sample	362.85 (445.4)	195.0 (420)		552.2 (956.9)	240.0 (468)		406.5 (510.6)	235.0 (444.7)		113.5 (179.4)	60.0 (137)		244.3 (439.8)	433.7 (947.7)	288.0 (519.8)
Sex															
Male	522.3(585.2)	280.0(690)		924.6(1537.2)	265.0(655)		398.9(494.1)	232.0(450.0)		168.7(199.1)	95.0(219)		353.6 (611.7) ^a	755.9(1543.4) ^a	230.3 (500.5)
Female	319.1(389.0)	180.0(405)		450.0(692.0)	240.0 (450)		408.5(516.1)	236.0(443.0)		104.8(145.1)	62.0(127)		214.3 (375.7) ^a	345.2 (680.9) ^a	303.8 (525.0)
Education															
<Bachelor's degree	389.0(482.4)	194.0 (465)		622.9(1084.8)	240.0 (565)		414.3(553.2)	206.0(524.5)		119.2(175.4)	60.0 (135)		269.8 (482.2)	503.7(1065.3)	295.1 (574.9)
Bachelor's degree	312.6(352.3)	183.0 (380)		504.7(883.5)	200.0 (463)		421.3(554.1)	240.0(343.0)		116.0(155.2)	73.0(122)		196.6(372.5)	388.7(904.5)	305.3 (568.7)
>Bachelor's degree	385.9(490.6)	212.5 (479)		492.3(805.6)	242.5 (417)		372.2(349.3)	242.0(416)		120.8(139.2)	88.5 (152)		265.1 (447.8)	371.5 (773.8)	251.4(308.7)
Annual household income															
<\$40,000	404.7(453.8)	300.0 (552)		743.14(979.1)	360.0 (815)		444.9(564.8)	206.0 (600.0)		129.5(231.9)	42.0(158)		275.1 (479.3)	613.6(983.4)	315.4(606.9)
\$40,000–79,999	319.5(452.0)	160.0(356)		524.7(1113.2)	200.0(321)		406.7(539.0)	225.5 (435.2)		126.3(141.8)	81.5 (155)		193.2 (440.3)	398.4(1104.4)	280.4(547.5)
\$80,000	384.0(433.2)	210.0(455)		463.0(722.9)	240.0 (333)		382.2(442.4)	240.0 (426.5)		103.2(119.5)	73.0(106)		280.8(411.8)	359.8(704.1)	279.1 (426.6)
Weight status															
Underweight or normal weight	416.4(450.7)	300.0 (460)		425.7(556.3)	205.0 (458)		444.6(400.9)	270.0 (570.8)		90.8(131.9)	56.0(114)		325.6 (440.9)	334.9 (560.9)	353.8 (397.1)
Overweight	342.0(416.4)	197.5 (364)		561.9(1007.7)	240.0 (473)		429.3(497.1)	243.0(431.5)		133.2(167.0)	94.0(137)		208.8(411.5)	428.7(990.5)	296.1 (505.4)
Obese	360.2(465.2)	180.0(438)		586.7(1023.4)	240.0 (453)		377.6(552.2)	180.0 (432.7)		117.1(163.3)	68.5 (151)		243.1 (458.4)	469.6(1018.1)	260.5 (564.7)

Note.

^aMean differences between self-reported IPAQ-S (t = 2.169, p = .031) and BRFSS (t = 2.991, p = .003) and accelerometer-assessed MVPA minutes per day were significantly different by sex.

Table 3

Unadjusted and Adjusted Pearson Correlations between Self-reported and Accelerometer-measured MVPA Minutes per Day

	IPAQ-S		BRFSS		PAQ	
	Pearson r (95% CI)		Pearson r (95% CI)		Pearson r (95% CI)	
Unadjusted	.214 ^{**}	(.084, .352)	.141 [*]	(-.002, .305)	.099	(.007, .214)
Adjusted^a	.1934 ^{***}	(.049, .347)	.115	(-.047, .292)	.095	(.001, .216)
Age	.219 ^{**}	(.090, .359)	.154 [*]	(.021, .322)	.096	(.001, .216)
Sex	.189 ^{**}	(.048, .338)	.111	(-.042, .285)	.101	(.012, .215)
Education	.214 ^{***}	(.082, .358)	.141 [*]	(-.005, .310)	.099	(.005, .212)
Income	.2144 ^{***}	(.087, .355)	.134 [*]	(-.007, .303)	.096	(.002, .221)
Weight status	.2164 ^{***}	(.067, .353)	.139 [*]	(.000, .305)	.101	(.009, .221)

*
p < .05;**
p < .01;***
p < .001

Note.

^a: Adjusted for age, sex, education, income and weight status combined.

Agreement between Self-report Questionnaires and Accelerometry for Classifying Persons as Meeting MVPA Recommendations (150 minutes/week)

Table 4

	Percent Agreement with Accelerometry		Cohen's κ	95% CI
	Met recommendations	Did not meet recommendations		
IPAQ-S	17.2	30.3	.054	−0.038 to 0.140
BRFSS	20.1	28.1	.107	0.027 to 0.189
PAQ	20.8	29.2	.136	0.058 to 0.216