Validity of the International Physical Activity Questionnaire in a rural Hispanic Population

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Introduction

Hispanics are among the fastest growing population in the United States (US)[1-3]. The prevalence of diabetes is disproportionately higher in some Hispanics, especially those of Mexican origin[4-8]. Based on data from the U.S. Centers for Disease Control's Behavioral Risk Factor Surveillance System (BRFSS) for the years 1998 – 2002, the age-adjusted self-reported prevalence of diabetes in Hispanics ages 18 and older was 9.8%, compared to 5.0% among non-Hispanic whites[9]. Self-reported data from the 2004 National Health Interview Survey (NHIS) and oral glucose tolerance tests from participants in the National Health and Nutrition Examination Survey (NHANES) also showed a two-fold elevation in diabetes prevalence among Hispanics (age-adjusted NHIS: 10.4% for Hispanics vs. 5.0% for non-Hispanic whites; NHANES ages 25 – 64: 8.4% for Mexican Americans vs. 4.3% for non-Hispanics whites, ages 65 – 84: 32.6% for Mexican Americans vs. 17.0% for non-Hispanic whites)[6].

There is evidence that physical activity is at least as important as diet in preventing and controlling diabetes[10-13]. Thus, measuring physical activity correctly is imperative for studies of diabetes and its control in order to correctly quantify and understand potential benefits. In studies where physical activity is not the primary exposure or outcome of interest, but a covariate or confounder, there is a need for self-report measures that are short, yet valid and reliable[14]. A number of different physical activity assessment tools are available to obtain estimates of physical activity (PA) levels in individuals and populations. The International Physical Activity Questionnaire (IPAQ) is one such tool, developed to provide a standardized instrument that can be used internationally to obtain comparable estimates of physical activity with little participant burden. Long and short versions of the instrument were originally developed and tested in twelve countries in 2003[15]. Since then, the IPAQ has been used as an instrument to estimate physical activity in various populations.

Validity studies have generally found modest associations between the IPAQ and objectively measured physical activity[16-19], which suggests that the IPAQ may not accurately capture important aspects of physical activity as assessed by "gold standard" field methods. It is plausible that variation in the IPAQ's measurement properties may be due to differences in translations as well as in the types of activities performed. For example, agricultural workers may heavily report job-related activities performed only during work hours, while people who occasionally engage in exercise may only report recreational activity performed after work hours. A recent review of twenty-three validation studies suggests that the short version of the IPAQ has poor correlation with objective measures of physical activity[20]. Other studies indicate that both versions of the IPAQ overestimate physical activity[21-23] and that the instrument has poor predictive validity[24]. Still, there is need for brief, yet relatively valid measures of physical activity in studies where that measurement is not the main outcome of interest.

The validity of the IPAQ has been tested in many languages, including Spanish[15,23-26]. However, Hispanics in the United States are a heterogeneous group. This raises the possibility that the validity and reliability of IPAQ-measured physical activity may vary among Hispanic sub-groups, such as rural farmworkers. Further, the authors who developed the IPAQ noted that the US samples were not representative of the U.S. population on whole due to small sample size[15] and few studies have examined the IPAQ in low economic and ethnic minority populations[15,24,26]. As a result, further investigation into the validity of the IPAQ in underrepresented populations is needed[15,25-27]. No studies have examined the IPAQ by varying levels of body mass index status (BMI); that is, it is not known if the instrument's measurement properties vary importantly between those who are and are not obese. Data from other studies suggests that there may be differences in how activity is recorded depending on body size[28]. Further, there may be important differences in how individuals with higher and lower BMIs perceive intensity of physical activity[29]. Therefore, the primary purpose of this study was to examine the criterion validity of the IPAQ-long versus an accelerometer in terms of total physical activity among a sample of rural Hispanics (Mexican-American) with diabetes, by BMI level. A secondary purpose was to assess correlations of moderate- and vigorous-intensity PA between the IPAQ-short and -long as compared to an accelerometer, overall and by BMI level. Given the results reported in the literature, we expect the IPAQ-long to have poor criterion validity. For the same reasons, we think that both versions will have poor correlation with accelerometer-measured physical activity at both moderate- and vigorous-level intensity.

Methods

Participant Recruitment and Eligibility

This validity study included a sample of sixty participants from the Partnership for a Hispanic Diabetes Prevention Program (PHDPP) – an ongoing randomized trial in the Lower Yakima Valley testing diabetes management strategies in Hispanics. The PHDPP has successfully screened over 6,000 people for Type II diabetes and has randomized approximately 400 participants, of whom 350 have completed the trial. We determined that with 60 participants, the study would have 93% power to detect a correlation of at least 0.50 between minutes measured by the IPAQ and the accelerometer. To meet our target sample size, we contacted 90 participants who were selected at random. We received approval for all research activities from the Fred Hutchinson Cancer Research Center Institutional Review Board.

Setting

The setting for this study was the Lower Yakima Valley, a region located in the south central area of Washington State near the Oregon border. The Yakima River, a tributary of the Columbia River, runs through this part of the state. Using the river to irrigate land, the economies of communities in this area are primarily linked to agriculture. Based on the 2010 U.S. Census, approximately 30% - 80% of residents in the Lower Yakima Valley identify as persons of Hispanic or Latino origin[30].

Data collection

At the first study appointment, participants filled out a questionnaire that asked about basic demographic and health status information including: highest grade completed, employment status, age, and acculturation. Acculturation was measured using a scale previously developed by Coronado GD, et al[31]. This acculturation scale takes into account: the language a person primarily thinks and speaks in, cultural self-identification, where the person was born, and how many years the person has lived in the area. The participant's height and weight were measured on a scale that was zeroed at the time of measurement. Participants were asked to wear the accelerometer on their hip for seven days and keep record of the days and times they put it on and took it off in the accelerometer wear log.

At the second appointment, which was scheduled for the eighth day, participants filled out the IPAQ-short and IPAQ-long questionnaires. The accelerometer and wear log were collected. Accelerometer data were downloaded using Respironic's proprietary software. Thirty dollars were provided to participants to thank them for participating in the study.

Instruments

Objectively measured PA was collected using the Respironic ActiCal® activity monitor (REF 1063544). This accelerometer is a relatively small (2.8 x 2.7 x 1.0 cm^3) and light (17g) unit that can be worn on the wrist, hip, or ankle. The accelerometer has a storage capacity of 64,800 data points and can continuously measure activity for approximately 44 days using 1-minute epochs[32]. This monitor senses motion using an omnidirectional accelerometer. The monitors are prepared and data downloaded via a "...serial port computer interface..." known as the ActiReader®[32]. The equations used to transform voltage signals into counts and then into energy and minutes is discussed in detail elsewhere[32].

The IPAQ is a 7-day recall questionnaire with two versions available in 21 languages including English, French, Spanish, Arabic, and Korean. The short version assesses frequency (days in the past week) and duration (minutes and/or hours per day) of walking, moderate, and vigorous intensity physical activity. The long version includes these items (frequency, duration, and the three intensity levels) and additionally asks about activity done at work, in transportation, at home, and in recreation. Each version asks the participant to only report activity that was done in at least 10-minute bouts. The IPAQ-short takes about 5-minutes to complete while the IPAQ-long takes about 15- to 20-minutes.

Data Processing and Cleaning

Wear time was determined from the accelerometer data. Hours of wear were determined by adding the minutes in wear time and dividing by 60. Wear time was defined as any interval of time with counts >100 that contained no intervals of time with 60 or more minutes of zero activity counts. We allowed this 60-minute interval to contain up to 2 minutes of activity between 0 – 100 counts. Typically, we checked the wear log that participants filled out to give us a reference point for when to start counting wear time. A valid day of wear was one in which a participant wore the accelerometer for at least 10 hours. Participants who did not wear the accelerometer on at least four days of the week, including one day on the weekend were excluded from the final dataset.

For the accelerometer, time spent in physical activity was measured by summing the 1-minute epochs. Minutes of physical activity performed in bouts were calculated using a modified 10-minute bout. These modified bouts are activity of at least moderate intensity that last for 10-minutes with allowance for 1-2 minute interruptions below the intensity threshold. Cut-off points for moderate (3.0 – 5.9 metabolic equivalents [MET]) and vigorous (greater than or equal to 6.0 MET) intensity levels were determined by the Actical monitor. Heil[33] explains the linear regressions used to determine these values from counts/minute in his validation study of the monitor. Total minutes in PA were calculated as the number of the minutes spent in bouts of moderate- to vigorous-level intensity.

IPAQ questionnaires were scored according to the protocol set forth by its creators[33]. For the current study, we examined two activity intensities: moderate-intensity activity, which included walking, and vigorous-intensity activity. Total moderate-to-vigorous activity minutes per week were a sum of the two. Those participants who reported high (>21 hours/week or 16 hours/day) amounts of activity in walking, moderate or vigorous intensities were not dropped from the analysis because we believe some participants were truly very active, and yet we did not want them to skew the data. Therefore, in order to help normalize the distribution, we employed the truncation rules described in the IPAQ protocol[33]. Specifically, if values of daily hours of physical activity exceeded 16 hours per day, these estimates were truncated to 16 hours. Likewise, if weekly hours for walking, moderate or vigorous intensity activity exceeded 21 hours for each category, it was truncated to 21 hours per week.

Participant's body mass index (BMI) was calculated as: (weight in pounds ÷ (height in inches)^2) * 703. There were two categories of BMI: non-obese consisting of normal and overweight (18.5 to 29.9 kg/m^2) and obese (30+ kg/m^2).

Data analysis

Summary tables were created to describe the sample by demographic characteristics (gender, age, obesity-status, employment, acculturation and education). Other tables were created to explore differences in mean minutes per week spent within each category of physical activity created (moderate, vigorous, total) as measured by the accelerometer (modified 10-minute bouts), IPAQ-short and IPAQ-long. Paired T-tests were used to test whether there were significant differences between time measured by the accelerometer and time measured by the IPAQ. Comparisons were made for gender, age group (<35, 35-44, 45-54, 55-64, 65+) and BMI (non-obese, obese).

Spearman's rank correlation coefficients were calculated to test the correlation between minutes in PA measured by the IPAQ and minutes measured by the accelerometer. Coefficients for the primary analysis compared total minutes in 10-minute bouts of physical activity. For the secondary analysis, the coefficients were calculated for comparisons by intensity (moderate and vigorous) and total moderate-to-vigorous physical activity.

Bland-Altman plots were created to assess the agreement between the two measures. These plots describe the agreement between two measures by plotting the mean between the two measures on the x-axis and the difference between the two measures on the y-axis. The mean difference between the two measures tells us whether there is a consistent under- or over-reporting. The limits of agreement show the upper and lower limits for which 95% of the differences lie. If the limits are wide, there is said to be a lack of agreement. Further explanation of Bland and Altman's theory and how this analysis works can be found elsewhere[34]. We plotted the mean score for the minutes per week against the difference between the two values, for each participant. This gives a relative measure of the bias, and thus the agreement, between the two measures. There are two Bland-Altman plots: IPAQ-long vs. accelerometer in total physical activity and IPAQ-short vs. accelerometer in total physical activity.

Results

Participant Demographics and Physical Activity

Sixty participants were recruited for the validity study. Of these, four did not meet the accelerometer wear-time requirements and one returned the accelerometer after the first day. These five participants were excluded from analyses. Characteristics of the 55 participants are presented in Table 1. On average, participants were 49.9 ± 12 years of age. The majority were female (81.8%, n = 45), obese (65.5%, n = 36), had low acculturation (78.2%, n= 43), and had an 8th grade education or less (69.1%, n = 38).

Participants performed an average of 1157.3 ± 505 minutes of total activity and 297.8 ± 316.2 minutes of total activity in 10-minute bouts during the observation period. Average total activity in 10-minute bouts varied when stratified by sex, five-year age categories, and obesity status(Table 4). In summary, males reported more minutes in 10-minute bouts of PA than females (574.7 vs. 236.3, respectively), but this difference was not significant. Average minutes of total PA in 10-minute bouts varied across the five age categories, spanning from the lowest among 65+ year olds to the highest among 35-44 year olds (96 and 434.5, respectively). Finally, non-obese participants reported more minutes of PA than obese ones, but this difference was also not significant.

Criterion Validity

Total minutes/week of PA, in 10-minute bouts, as measured by the IPAQ-short and long, were weakly correlated with that measured by the accelerometer (**ρ**: 0.33 and 0.32, respectively). The IPAQ-short had better correlation than the IPAQ-long when looking at moderate-intensity PA in 10-minute bouts (0.34 vs. 0.28). There were differences in the observed estimates when the comparisons were stratified by obese and non-obese status, ranging from 0.24 – 0.30 (Table 3).

Bias

The mean difference between the IPAQ-short and accelerometer in back-transformed log-minutes of total PA was 1.51 (limits of agreement: 0.08 and 26.84, Figure 1). The limits of agreement contain about 95% of the differences between the two measures and allow for visual inspection of how well the two measures agree; the smaller the range, the better the agreement. The mean difference was larger and the limits of agreement were wider for the IPAQ-long (mean difference of 4.14 with limits of agreement between 0.32 and 53.52, Figure 2).

Visual-inspection of the plots revealed that there was a substantial amount of bias between the two measures as well as a number of observations that fell outside the limits of agreement for both versions of the IPAQ (Figures 1 & 2). The IPAQ-short has few observations that fall along the mean difference. This is constant across all values for the mean difference between the two measures. The IPAQ-long also had few observations along the log-mean continuum, with a hint of clustering at higher values (Figure 2). Self-reported PA was typically higher than the accelerometer-measured PA given by the mean difference values being higher than zero.

Discussion

To our knowledge, this is the first study to assess the validity of the IPAQ in a group of rural Hispanic diabetics. In this sample, we found that the validity of the questionnaire was below the minimal acceptable standard (0.50 for objective activity measuring devices, 0.40 for fitness measures)[20] expected from self-report physical activity questionnaires. We also found in our sample that in total PA, both versions of the IPAQ generally overestimated PA, the IPAQ-long more than the IPAQ-short.

Studies that have tested the validity of the IPAQ in Hispanic and other minority populations had similar results as the current one: poor correlation with objective measures of PA and a general tendency for both versions of the IPAQ to overestimate PA. In a 2009 dissertation, Dang[24] tested the validity of the IPAQ-short in a sample of 97 Mexican American adults. He found that the questionnaire had acceptable test-retest reliability, but unacceptable predictive validity when compared to objective measures such as THF-α, Adiponectin, and HDL. A study by Nicaise et al[35] among Hispanic women living in San Diego found that the IPAQ-long overestimated physical activity. Wolin et al[26] explored the validity of the IPAQ-short in U.S. Blacks. In this study, the short version of the IPAQ had fair agreement to the accelerometer-measured PA (r = .36 for 1-minute bouts), correlations were higher among men than women, and that only 25% of individuals were classified as meeting PA guidelines by both instruments.

Lee et al[20] conducted a recent systematic review of the literature validating the short-form IPAQ against objective measures of PA. Twenty-three validation studies were reviewed. Correlations between the two measures in total PA ranged from 0.09 to 0.39. Vigorous- or moderate-level activity had greater variability in the reported correlation coefficients (-0.18 to 0.76). This systematic study concluded that the majority of the studies reported correlations between the IPAQ-short and objective measures of PA that were lower than the acceptable standard and that the IPAQ-short typically overestimated physical activity "...by an average of 84 percent."

The correlations found in the current validation study were similar to those summarized in the systematic review. There were no correlations that reached the minimal acceptable standard reported by Lee et al. In general, we cannot tell if there is a difference in correlations between obese and non-obese participants as the 95% CI overlap (Table 2). The highest coefficient was found for the IPAQ-short, in moderate PA, and among obese participants (**ρ**: 0.34; 95% CI: 0.05 – 0.64). The correlation coefficient for the IPAQ-long, in total PA and among obese participants, was similar (**ρ**: 0.32; 95% CI: 0.05 – 0.59).

The Bland-Altman plots suggest that measures of physical activity from both versions of the IPAQ have poor agreement with that from the accelerometer. The IPAQ-short had few observations that were near the mean difference as most were scattered away from it. In addition, the range of the limits was wide, suggesting poor agreement. Further, the two measures had a mean difference of 1.51, suggesting that the IPAQ-short generally overestimated total physical activity in this sample. The plots for the IPAQ-long had wider limits and a higher value for the mean difference (4.14). In total, the IPAQ-short had fewer observations outside of the limits of agreement, a smaller mean difference, and narrower limits of agreement compared to the IPAQ-long.

This study has a number of limitations. One major limitation is the use of accelerometers as the objective measure. Although these are objective measures of time spent in physical activity and are commonly used to examine the criterion validity of PA questionnaires, there are some activities that they cannot differentiate well. For example, an accelerometer is unable to distinguish walking on level ground vs. walking up a hill or measure energy expended by picking fruit from trees and other activities that involve upper body motion such as using a shovel, carrying boxes of fruits or vegetables, climbing up and down ladders, and pushing a lawn mower. Accelerometers may not be an appropriate "gold standard" by which to compare other measures. Thresholds for calculating intensity-levels of physical activity may be too rigid for this population[36,37]. For example, thresholds for moderate- and vigorous-intensity activity may be too high for elderly and obese participants, who may perceive a threshold-determined moderate activity as vigorous. Another limitation, foreseen by the creators of the IPAQ, is the non-normal distribution of reported minutes per week in moderate, vigorous, and total PA. We attempted to normalize the distribution by implementing the truncation guidelines outlined in the IPAQ scoring protocol. This, necessarily, lowered the average reported minutes/week for the sample. Another limitation is our sample size. This can be observed by the range of the 95% CI for our

Spearman's coefficient estimates. Indeed, this study was not well powered to detect correlation coefficients as low as the data produced, which warrants careful interpretation of the estimates, especially those for the comparing correlations stratified by obesity status.

In research studies of physical activity, it is ideal to have valid means of measurement that are not overly burdensome, yet reliable and accurate. The IPAQ-short is easy to use and has low participant burden, but demonstrated poor correlation to objectively measured PA and generally overestimated PA as determined by the Bland-Altman plots. For these reasons, the IPAQ-short may only be useful in measuring physical activity if that measurement is of secondary importance in a study. The IPAQ-long also had below acceptable correlation and the results from the Bland Altman plots suggest that the IPAQ-long can also overestimate PA and has considerable amounts of bias in its measurement of PA. Researchers should carefully weigh the costs and benefits of using these questionnaires based on what they deem acceptable.

Table 1. Participant Characteristics

	N	%	Age (years) Mean	Age (years) SD	Body mass index (kg/m²) Mean	Body mass index (kg/m²) SD
Total	55	100	49.8	11.9	31.9	7.4
Gender						
Male	10	18.2	52.1	8.3	29.7	3.8
Female	45	81.8	49.4	12.6	32.4	7.9
Age						
<35	8	14.5	30.4	2.9	32.6	11.3
35 – 44	10	18.2	41.3	2.6	30.3	4.5
45 – 54	19	34.5	50.3	2.5	32.0	8.9
55 – 64	12	21.8	59.2	2.6	32.3	5.5
65+	6	10.9	70.2	4.7	32.3	4.5
Obesity						
Non-obese	19	34.5	47.2	11.1	25.8	2.3
Obese	36	65.5	51.3	12.3	35.2	7.1
Employment						
Full-time	16	29.1	48.2	8.2	32.3	9.6
Part-time	2	3.6	41	19.8	25.6	1.8
Temporary	2	3.6	31	4.2	29.7	2.2
Unemployed	35	63.6	52.1	12.3	32.2	6.6
Acculturation						
Low	43	78.2	48.1	10.9	31.2	7.1
Moderate High	4	7.3	62.5	14	32.2	5.4
High	8	14.5	52.9	12.5	35.4	9.8
Education						
≤4th grade	22	40	52.1	9	30.9	4.8
5th – 8th grade	16	29.1	47.3	13.4	32.4	9.9
9th – 12th grade	11	20	48.7	13.7	31.8	3.8
HS Grad or GED	2	3.6	55	31.1	45.7	7.1
Some college	3	5.5	50.7	8.1	26.1	2.8
Other	1	1.8	43	-	36.5	-

Table 2. Spearman's Rank Correlation Coefficients for PA in 10-minute bouts by obesity status.

	Spearman's Coefficient (ρ)	95% CI			Spearman's Coefficient (ρ)	95% CI
IPAQ-short				**IPAQ-long**		
Moderate Intensity				*Moderate Intensity*		
Total (n=55)	0.34	0.09, 0.59		Total (n=55)	0.28	0.03, 0.53
Obese (n=36)	0.34	0.05, 0.64		Obese (n=36)	0.28	-0.02, 0.52
Non-obese (n=19)	0.30	-0.24, 0.73		Non-obese (n=19)	0.25	-0.25, 0.75
Vigorous Intensity				*Vigorous Intensity*		
Total (n=55)	-0.09	-0.14, -0.03		Total (n=55)	0.16	0.02. 0.30
Obese (n=36)	--	--		Obese (n=36)	--	--
Non-obese (n=19)	-0.16	-0.28, -0.03		Non-obese (n=19)	0.21	-0.10, 0.52
Overall Total PA				*Overall Total PA*		
Total (n=55)	0.33	0.08, 0.59		Total (n=55)	0.32	0.07, 0.56
Obese (n=36)	0.36	0.07, 0.65		Obese (n=36)	0.32	0.05, 0.59
Non-obese (n=19)	0.26	-0.23, 0.74		Non-obese (n=19)	0.25	-0.30, 0.67

Table 3. Spearman's Rank Correlation Coefficients for minutes of PA in counts >100.

	Spearman's Coefficient (ρ)	95% CI			Spearman's Coefficient (ρ)	95% CI
IPAQ-short				**IPAQ-long**		
Overall Total PA				*Overall Total PA*		
Total (n=55)	0.28	0.02, 0.54		Total (n=55)	0.27	0.03, 0.52
Obese (n=36)	0.30	-0.004, 0.61		Obese (n=36)	0.24	-0.06, 0.51
Non-obese (n=19)	0.26	-0.21, 0.69		Non-obese (n=19)	0.27	-0.20, 0.74

Table 4. Physical activity over 7 days as measured by Accelerometer, IPAQ-short and IPAQ-long (minutes).

	Accelerometer				IPAQ-Short			IPAQ-Long		
	Mod#	**Vig#**	**Total#**	**Total***	**Mod**	**Vig**	**Total**	**Mod**	**Vig**	**Total**
Total	297.5 (316.1)	0.3 (2.4)	297.8 (316.2)	1157.3 (505.1)	391.2 (526.4)	132.9 (315.5)	524.1 (761.4)	955.9 (723.7)	187.9 (415.3)	1143.8 (1409.3)
Sex										
Male	574.7 (543.8)	0 (0)	574.7 (543.8)	1402 (755.6)	649.5 (775.8)	204 (416.8)	853.5 (1153)	928.5 (764.2)	294 (486.2)	1222.5 (1188.5)
Female	235.9 (201.8)	0.4 (2.7)	236.3 (202.2)	1102.9 (423.7)	333.8 (445.5)	117.1 (291.9)	450.9 (640.1)	961.9 (723.3)	164.3 (400.3)	1126.3 (1018.8)
Age (years)										
<35	165.4 (109.8)	0 (0)	165.4 (109.8)	1034 (236.7)	350.6 (400.9)	101.3 (251.9)	451.9 (482.7)	1155.6 (971)	318.8 (581)	1474.4 (1505.2)
35 - 44	434.5 (316.7)	0 (0)	434.5 (316.7)	1441.4 (510.2)	479 (465.2)	378 (507.6)	857 (947.6)	1216.5 (719.7)	384 (508.5)	1600.5 (1098.8)
45 - 54	366.6 (406.9)	0.9 (4.1)	367.5 (407.1)	1278 (596.6)	405.5 (666.3)	125.8 (309.9)	531.3 (939.8)	905.5 (814.7)	142.9 (394.9)	1048.4 (1076.8)
55 - 64	262.8 (247.6)	0 (0)	262.8 (247.6)	1047.2 (374.1)	364.2 (391.5)	20 (53.3)	384.2 (430.7)	862.1 (465.7)	102.5 (295.2)	964.6 (660.1)
65+	96 (122.7)	0 (0)	96 (122.7)	686.5 (487.4)	307.5 (643.5)	15 (36.7)	322.5 (636.9)	602.3 (396.7)	0 (0)	602.3 (396.6)
BMI (kg/m^2)										
<30	326.5 (414.1)	0.9 (4.1)	327.5 (414.4)	1273.3 (608.9)	524.7 (693.7)	243.2 (481)	767.6 (1089.9)	1235.5 (840.2)	279.5 (522.1)	1515 (1257.8)
≥30	282.2 (255.3)	0 (0)	282.2 (255.3)	1096.1 (437.7)	320.8 (406.7)	74.7 (156.6)	395.6 (484.2)	808.3 (616.7)	139.6 (344.9)	947.9 (861.6)

Table values presented as mean (sd)
Modified 10-minute bouts
* Minutes of counts >100

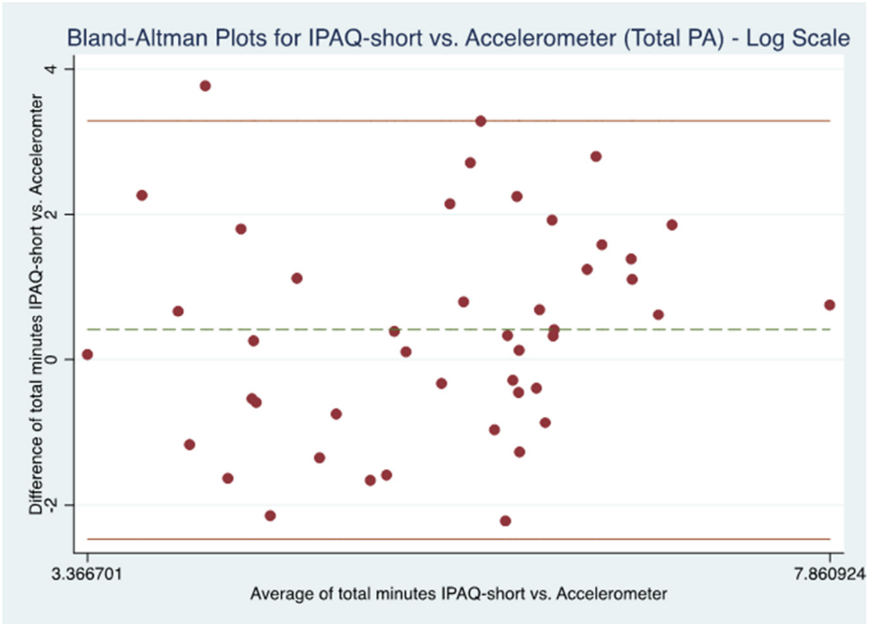

Figure 1. Bland and Altman Plot of the data obtained from 55 samples analyzed on the IPAQ-short and the Accelerometer in 10-minute bouts. Back-transformed mean difference = 1.51; Limits of agreement: 0.08, 26.84.

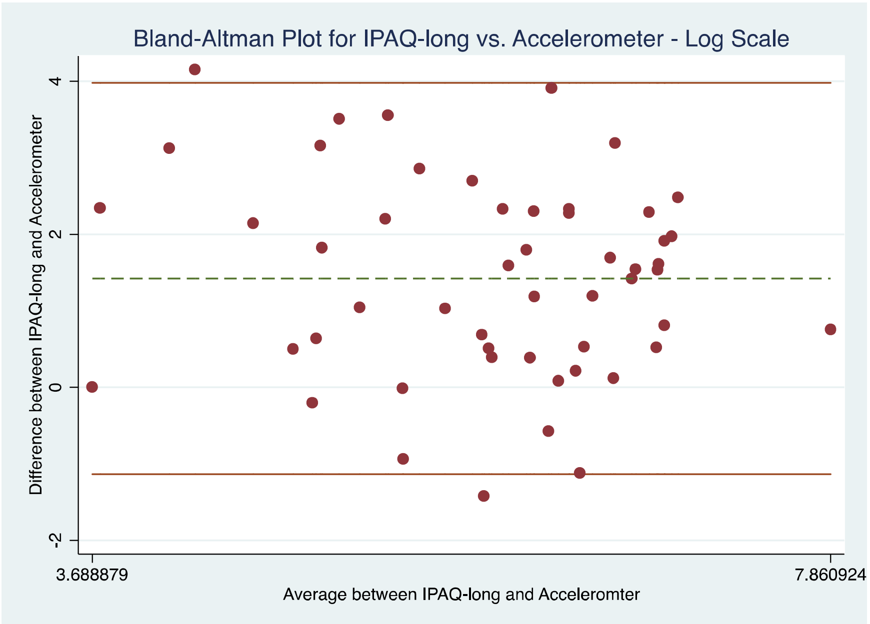

Figure 2. Bland and Altman Plot of the data obtained from 55 samples analyzed on the IPAQ-long and the Accelerometer in 10-minute bouts. Back-transformed mean difference = 4.14; Limits of agreement: 0.32, 53.52.

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