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RELIABILITY AND VALIDITY OF INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE, BAHASA MALAYSIA VERSION: A PRELIMINARY STUDY

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ABSTRACT

The International Physical Activity Questionnaire (IPAQ), a standardised method for assessing physical activity, has been tested at 14 centres in 12 countries on adults aged 18 to 65 years. However, there is no standardised instrument to determine levels of physical activity amongst Malay-speaking adults in Malaysia. The aim of this study was to develop the IPAQ Bahasa Malaysia version (IPAQ-BM), test its psychometric values and determine the gap (under or over estimation) in levels of physical activity in a pilot study involving multi-ethnic Malaysians. The IPAQ (long form) was translated into Bahasa Malaysia (IPAQ-BM), culturally adapted and content validated. The correlation between the IPAQ-BM and the accelerometer were low to moderate (r=0.13-0.41). The IPAQ-BM overestimated the accelerometer by 416% for vigorous intensity activity and only 1.6% for moderate intensity activity in this group. Future studies involving stratified sampling for several age groups and larger samples are warranted.

Key words: Validity; Reliability; Physical activity; Accelerometer; Estimations; IPAQ.

INTRODUCTION

There is increasing evidence that physical inactivity is a determinant for a range of non-communicable diseases (NCDs) such as obesity, osteoporosis, Type II diabetes mellitus, hypertension, cardiovascular diseases, depression, and even cancer (Liu *et al*., 2011). The World Health Organization (WHO) projects that over the next 10 years NCD deaths will increase by 17% with the highest number of deaths occurring in Asia (WHO, 2000).

Asian and Pacific countries are known for the diversity in psychological, social, cultural factors and different life styles and means of living. Therefore, it is dangerous to assume that physical activity-based approaches to NCD that have been shown to work effectively in Western and European regions will work equally well among people from developing nations like Malaysia, Brunei, Indonesia, Singapore and Samoa (Khoo & Morris, 2012). The difficulty in assessing physical activity, however, lies primarily in the lack of understanding of the pattern and trends of physical activity within a nation (Fox & Hillsdon, 2007). There are inconsistencies with the measurement tools making comparison difficult as physical activity is a complex exposure and a diverse behaviour (Caspersen *et al*., 1985). Therefore, without an accurate measure of physical activity, it is difficult to quantify its beneficial relationship with health (Rowlands, 2007). Accuracy in physical activity measurement tools is significant in determining the risk factors of a range of NCDs (Oyeyemi *et al*., 2011).

The International Physical Activity Questionnaire (IPAQ) was developed to address these concerns by a group of experts in 1998 to facilitate the surveillance of physical activity based on a global standard (Lee *et al*., 2011). The IPAQ has since become the most widely used questionnaire to determine levels of physical activity within a population (Lee *et al*., 2011). There are versions available, such as the 27-item long form (IPAQ-LF) and the nine-item short form (IPAQ-SF), both of which involve a seven-day recall of physical activity. The short form consisting of 8 items was designed to estimate the time spent performing physical activity (moderate to vigorous) and inactivity (time spent sitting) in population studies where time is limited (Macfarlane *et al*., 2007). However, the long form which comprises of 27 items was designed to provide comprehensive evaluation of daily physical activity, and assess the time spent walking, doing moderate intensity and vigorous intensity activity within the domains of work, transportation, domestic and gardening activities, and leisure-related activities.

Both the short and long versions of the IPAQ have been used in healthy (Craig *et al*., 2003; Rutten *et al*., 2003), disease-specific (Faulkner *et al*., 2006), and HIV-infected populations (Fillipas *et al*., 2010). The IPAQ short version has been translated and validated in several countries (Ainsworth *et al*., 2000a; Hallal & Victora, 2004; Hemmingsson & Ekelund, 2007; Macfarlane *et al*., 2007). The IPAQ long version has been validated in different countries and cultures around the world (Craig *et al*., 2003; Ekelund *et al*., 2006). Eight different forms were developed from the IPAQ and were tested in 14 centres in 12 countries during the year 2000 (Ekelund *et al*., 2006).

In this study, the IPAQ long version was selected for the purpose of validation. Firstly, the longer version is more ideal to be used in research studies that require a detailed dimension on the levels of physical activity (Craig *et al*., 2003) as the data are reproducible. Secondly, it is able to provide better estimations for a range of physical activities according to domains when compared to the shorter version of IPAQ (Craig *et al*., 2003). The cut-off points for counts per minute (cpm) for this study were set at 0 to 99cpm for sedentary, 100 to 1951cpm for light intensity, 1952 to 5724cpm for moderate intensity, 5725 to 9498cpm for vigorous intensity and 9499>cpm for very vigorous intensity (Freedson *et al*., 1998; Hagstromer *et al*., 2006).

PURPOSE OF STUDY

To date, no studies have shown the overestimates of the IPAQ-BM when compared with an accelerometer used as a criterion measure in Asian population. Most of the validation and overestimations were carried out among the Western population. Therefore, the aim of this study was:

(1) To compare accelerometer-based and self-reported measures of recent moderate-to-vigorous physical activity (MVPA); and

(2) To determine how much the IPAQ-BM overestimates the level of physical activity in an Asian population.

METHODOLOGY

Subjects and design

This was a cross-sectional study conducted in a residential college from a university in Malaysia. Purposive random sampling was applied. Effect size (ES) was used to determine the sample size for this study and the ES was derived to be about 0.5 between the paired samples (Macfarlane *et al.*, 2007; Cerin *et al.*, 2011). Considering the power to be 0.2 and α=0.05, 34 participants were required for this study. The data collection was carried out from September and December 2014.

Ethical approval

All participants consented to participate in the study. The Ethics Committee of the University of Malaya Medical Centre approved the study (Ethics Committee Reference Number 968.42; 6 February 2013). Participants were assured of confidentiality and anonymity. They were informed that they could withdraw from the study at any stage without any repercussions.

Physical activity by self-report

Self-reported physical activity was obtained through the last 7 days for the long version of the self-administered IPAQ-BM. The questionnaire collects information on time spent on moderate and vigorous intensity activities and time spent walking and sitting on weekdays and weekends. Data from each question were summed within the item (i.e. moderate and vigorous) to estimate the total amount of time spent in physical activity in the last 7 days. The reported time for each activity was then multiplied with the designated MET value to each category to estimate the total daily physical activity (MET-min-day).

MET is the Metabolic Equivalent of Task and 1 MET is resting energy expenditure according to the official IPAQ scoring protocol and the compendium by Ainsworth *et al.* (2000b). One MET unit is defined as the energy expenditure for sitting quietly, which for an average adult is 3.5ml of oxygen x kg bodyweight $^{-1}$ x min^{-1} or 1 kcal x kg body weight^{-1} x h^{-1}(Ainsworth *et al.*, 2000b). The minutes were converted to hours and weekly energy expenditure from each physical activity (Kcal/week) was calculated as follows: hours spent on activity per day x numbers of days per week x MET value (Ainsworth *et al.*, 2000b). Then the energy expenditures from all the activities under each intensity category were combined to obtain the total energy expenditure per week for both moderate and vigorous intensity activities. Vigorous intensity was defined as 6 METs or more, moderate intensity was defined as 3 to 6 METs and low intensity was below 3 METs.

Criterion measurement of physical activity

Objective measurement of physical activity was obtained by using the ActiGraph® GT3X+ accelerometer, which is a small (3.8cm x 3.7cm x 1.8cm) and lightweight (27 grams) device comprising a tri-axial transducer, used to monitor activity every minute for 7 days. The

ActiGraph®GT3X+ accelerometer recorded physical activity in a series of activity counts, which were proportional to the magnitude and duration of the sensed accelerations. The raw minute-by-minute activity counts were then transformed into energy expenditure by the computer programme using MET prediction algorithms (Nang *et al.*, 2011). Accelerations ranging between 0.05 to 2.0*g* are measured by a piezoelectric sensor, sampled at 10Hz, and then summed over a selected time interval (epoch).

The ActiGraph® GT3X+ accelerometer has been validated extensively in various settings suggesting high reliability and validity for quantifying intensities of physical activity (Freedson *et al.*, 1998; Hendelman *et al.*, 2000; Brage *et al.*, 2003; Ekelund *et al.*, 2006). The average intensity that was measured over the last 7 days (average counts per minute) has shown to be significantly associated with estimate energy expenditure by the double-labelled water method under free-living conditions in children, adolescents, young athletes and adults (Ekelund *et al.*, 2001; Leenders *et al.*, 2001; Ekelund *et al.*, 2006).

The accelerometer was initialised and epoch was set at a 1-minute interval. Data from the device was downloaded and analysed using the ActiGraph software provided by the manufacturer. The main outcome was the average intensity of physical activity counts per minute (cpm) representing sedentary (<100cpm), light (100 to 1951cpm), moderate (1952 to 5724cpm), vigorous (5725 to 9498cpm) and very vigorous (9499>cpm) intensity of physical activity (Ekelund *et al.*, 2001). These cut-offs were previously used in global reliability and validity studies using IPAQ (Craig *et al.*, 2003) and the accelerometer (Ekelund *et al.*, 2002). The participants were asked to wear the device on the right hip during waking hours except during water activities over a period of 7 days. According to the criterion for registered time, all subjects except 1 (excluded from the data analyses) recorded an average of 10 hours per day with more than 600 minutes of valid movement recording.

The participants were instructed on how to wear the ActiGraph® GT3X+ accelerometer, which was initialised to record physical activity from Day 1 to Day 7. Participants were contacted again on Day 8, when the accelerometer was collected and the IPAQ-BM was administered.

Calculation of energy expenditure from physical activity

For the IPAQ-BM, the data processing protocol was used (Committee, 2005) to compute the energy expenditure. Moderate activities and walking for all the domains were combined to derive the moderate intensity physical activity scores. The same was performed for vigorous intensity activities. The Metabolic Equivalent of Tasks (MET) scores were obtained from the IPAQ scoring protocol, which is also available on the www.ipaq.ki.se website and from the Compendium of Physical Activity Tracking Guide by Ainsworth *et al*. (2000b).

One MET unit is defined as the energy expenditure for sitting quietly, which for the average adult is approximately 3.5ml of oxygen x kg of bodyweight^{-1} x min^{-1} or 1 kcal x kg of bodyweight^{-1} x h^{-1} (Ainsworth *et al*., 2000a; Nang *et al*., 2011). Then, the energy expenditure from all the activities under each intensity category was summed to obtain the total energy expenditure per week for moderate and vigorous intensity respectively. MET scores of $\leq$3 METs were categorised as low intensity, 3 to 6 METs were categorised as moderate and $\geq$6 METs were categorised as vigorous intensity. The scores were obtained from the IPAQ-BM were explored per variable except for item number 1 which asked whether the respondent has a job or not. The frequency was multiplied with the duration to generate the MET intensity, which was matched to the MET value from the Compendium of Physical Activity Tracking Guide by Ainsworth *et al*. (2000b) and categorised as moderate and vigorous intensity.

The data from the ActiGraph® GT3X+ accelerometer were recorded in counts per minute (cpm) from ambulatory accelerations in proportion to the duration and magnitude from 3 axes. The ActiGraph® software automatically computes the raw data into MET prediction algorithms by selecting the cut off points for MET scores and cut-off guidelines for physical activity intensity. The cut-off points for physical intensity that was used for interpreting this data was Freedson Adults 1998 (Freedson *et al*., 1998).

Statistical analyses

Data from the accelerometer were considered valid when data for 10 hours or more were collected for at least 5 days. Data from 3 accelerometers, which had technical problems, were excluded from the analyses. In addition, 1 participant did not comply with the study protocol and had less than 10 hours of data recorded was also excluded from the analysis. Spearman's Rank Correlation test was used to determine the correlation between the estimates of energy expenditure from physical activity assessed by the IPAQ-BM and estimates of energy expenditure assessed by the accelerometer. The reliability of the IPAQ-BM was evaluated using the Spearman Rank Correlation coefficients. Descriptive analyses in SPSS for Windows version 16.0 were used to interpret the data from the socio-demographic form in the percentages and mean and standard deviations and CI of 95%. Spearman's Rank Correlation Coefficient (Rho) was used to examine the correlation between both the IPAQ-BM and the ActiGraph® GT3X+ accelerometer.

RESULTS

Table 1. **CHARACTERISTICS OF STUDY POPULATION**

Characteristics	**Females** (n=19) Mean±SD (min-max)	**Males** (n=19) Mean±SD (min-max)	**Total group** (N=38) Mean±SD
Age (years)	22.17±1.04	22.32±1.95	22.24±1.53
Height (cm)	158.11±7.46	171.68±6.69	164.00±0.09
Body mass (kg)	53.26±13.68	62.42±11.95	57.84±14.49
Body Mass Index (kg/m^2)	21.24±4.07	21.11±3.49	21.18±3.74
BMI groups:			
Underweight <18.5	17.32±0.80 (16.2-18.3)	17.23±0.71 (16.3-18.2)	17.27±0.71
Normal 18.5–24.9	21.09±2.31 (18.5-24.7)	21.79±1.56 (20.1-24.2)	21.42±1.97
Overweight 25.0–29.9	26.85±0.64 (26.4-27.3)	26.63±2.17 (25.0-29.1)	26.72±1.57
Obese >30.0	31.40±0.00 (31.4-31.4)	–	15.70 ±22.20

In total, the 51 participants who were invited to participate in the study met the inclusion criteria. All the participants were college students and participated in various activities from art to sport and even those in the reserved officers training unit. However, only 38 (19 females, 19 males) healthy college young adults wore the ActiGraph® GT3X+ accelerometer for 7 consecutive days and completed a self-administered IPAQ-BM.

The mean age for the total group was 22.24±1.53 and the mean Body Mass Index was 21.18±3.74kg/m^2. The socio-demographic characteristics of the participants are shown in Table 1. The means score for moderate intensity physical activity reported by the IPAQ-BM and accelerometer were 180.00±206.97 and 177.16±88.81 respectively with a difference of 2.84±201.0 ($p<0.05$). The IPAQ-BM seemed to have been over estimated by 1.6%. Even though there was a significant overestimate, it was marginal compared to the over estimation for vigorous intensity physical activity of 416%. The mean scores for vigorous intensity physical activity reported by the IPAQ-BM and accelerometer were 17.89±67.51 and 3.47±7.46 respectively with a mean difference of 14.42±62.6 ($p<0.05$). The mean and standard deviation for the moderate and vigorous intensity physical activity for both IPAQ-BM and the accelerometer are shown in Table 2 and Table 3 respectively.

Table 2. **DIFFERENTIAL SCORE BETWEEN IPAQ-BM AND GT3X+ FOR MODERATE INTENSITY ACTIVITY**

Instrument	Mean±SD	Min–Max	p*	p**
IPAQ-BM	180.00±206.97	35-850		
GT3X+	177.16±88.81	21-385		
Difference	2.84±201.00	—	0.931	0.243

* p<0.05 ** p<0.001 Min=Minimum score Max=Maximum score

Table 3. **DIFFERENTIAL SCORE BETWEEN IPAQ-BM AND GT3X+ FOR VIGOROUS INTENSITY ACTIVITY**

Instrument	Mean±SD	Min–Max	p*	p**
IPAQ-BM	17.89±67.51	0-360		
GT3X+	3.47±7.46	0-34		
Difference	14.42±62.6	—	0.164	0.096

* p<0.05 ** p<0.001 Min=Minimum score Max=Maximum score

Table 4. **TOTAL ACTIVITY FROM IPAQ-BM AND GT3X+ FOR SEVEN DAYS**

	IPAQ Mean±SD (min-max)		**GT3X+ Mean±SD (min-max)**	
Gender	Moderate intensity	Vigorous intensity	Moderate intensity	Vigorous intensity
Females (n=19)	236.84±253.21 (35-850)	8.42±36.71 (0-160)	176.26±76.94 (21-302)	3.89±6.79(0-22)
Males (n=19)	123.16±130.83 (35-630)	27.36±88.49 (0-360)	178.05±101.45(22-385)	3.05±8.25(0-34)

Table 4 shows the combined total activity for moderate and vigorous intensities measured by both the IPAQ-BM and accelerometer.

The results from Spearman's Rank Correlation Coefficient (r) for the total time spent in physical activity from IPAQ and GT3X+ for both genders are displayed in Table 5.

Table 5. **CORRELATIONS (r) BETWEEN IPAQ AND GT3X+ FOR BOTH GENDERS**

Physical activity	**Females (r)**	**Males (r)**
Moderate intensity	0.35	0.27
Vigorous intensity	0.13	0.41

For *moderate intensity* physical activity, correlations for the males (r=0.27) between the tools seemed to be slightly lower than that for the females (r=0.35). According to Cohen's guidelines for classifying correlations, r<0.3 is considered small or weak. This indicated that the correlation for moderate intensity activity for the females was moderate.

With *vigorous intensity* physical activity, the correlation for the males was much higher (r=0.41) when compared to the females (r=0.13). This means that results from the IPAQ-BM and the GT3X+ for vigorous intensity activity for the males were moderately correlated, whilst for females, they correlated weakly. This could be because the males had a better capacity to recall the vigorous activities they had performed over the last 7 days. The low correlation coefficient (r=0.13) for vigorous intensity activities between the subjective IPAQ and objective GT3X readings for the females indicated that they might not have reported their levels of physical activity in the IPAQ-BM accurately.

DISCUSSION

The accelerometer is generally considered to be the 'gold standard' for measuring moderate to vigorous intensity physical activity (Boyle *et al*., 2015). However, its application is time consuming and cumbersome. In the current study, which was conducted among young adults living in a public university in an urban area, IPAQ-BM showed substantial over reporting of physical activity for vigorous intensity, which was 416%. However, for moderate intensity, there was a slight percentage of over reporting which was only 1.6%. This amount is significant but marginal. The findings in our study were similar to previous validation studies using the IPAQ long-form and criterion validated the questionnaire with the accelerometer.

There were no substantial discrepancies between ethnicities. However, there was a substantial difference between the moderate intensity correlation between females and males. Higher correlation values (r=0.35) were found for the females than the males (r=0.27). Possible reasons why the correlation was higher in the case of the females are, (1) the majority of the female population had a better capacity to recall the moderate intensity activities that they had performed in the last seven days when compared to the males; (2) instead of reporting moderate intensity activity, the males had reported the level of activities that they had performed as vigorous intensity. The correlation scores (r=0.41) for the males for vigorous intensity were higher when compared to females (r=0.13). This suggests that either most of the men reported their PA levels as accurate as possible regarding what they were doing on a daily basis or they had a better capacity to recall activities that they had done over the last seven days. In addition, most the men perform high intensity exercises and training outdoors.

The correlation between the IPAQ-BM and the accelerometer for the current population seems to be similar to other populations where the vigorous intensity activity had higher correlations than the moderate intensity activity. Results from a study conducted for a New Zealand population was 0.19 for moderate activity and 0.42 for vigorous activity (Boon *et al*., 2010). Correlations in a Swedish population was 0.21 for moderate and 0.71 for vigorous activity (Hagstromer *et al*., 2006). A validation study (Macfarlane *et al*., 2010) conducted for an Asian population in Hong Kong also reported low correlations for moderate (r=0.27) and for vigorous activity (r=0.28). A study in Singapore (Nang *et al*., 2011) reported high to moderate correlations (r=0.18 and r=0.13) for vigorous activity.

CONCLUSION

In conclusion, IPAQ-BM has been proven to be a reliable and valid instrument to assess levels of physical activity and suitable for use as a screening instrument among the Malay-speaking Malaysian population. The findings of the study indicate that the IPAQ-BM could measure moderate intensity activity with strong evidence of correlation and validity, whereas the measurement properties for assessing vigorous were acceptable due to the significant correlations between both the subjective and objective instruments. The IPAQ-BM warrants further research by using a larger sample with diversities in age, occupation and socio-economic status to acquire better data about the levels of physical activity among Malaysians. Findings from a larger cohort could provide a better representation of their current levels of physical activity. Accurate and appropriate measurement using the subjective IPAQ would better inform and recommend guidelines, with agreed consensus from both researchers and clinicians to help facilitate people to engage in the required level of physical activities.

Competing interest

The authors declare they have no competing interests.

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