Comparing physical activity levels of Malay version of the IPAQ and GPAQ with accelerometer in nurses

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Abstract

Objectives: There is strong evidence that regular physical activity (PA) is associated with significant health benefits for individuals of all ages. Therefore, it is necessary to have an accurate assessment of PA levels to ensure that individuals participate in sufficient PA to gain health benefits. This study compared PA levels obtained from the Malay language versions of the International Physical Activity Questionnaire (IPAQ-L: M) and Global Physical Activity Questionnaire (GPAQ: M) with those from a PA log and accelerometer. Study Design: Experimental – Cross Sectional study Methods: Data were collected from 43 female nurses aged 24 to 55 years (44.48 ± 8.38 years). In this cross-sectional study, participants answered the IPAQ-L:M or GPAQ:M and wore the accelerometer for seven consecutive days and answered GPAQ:M or IPAQ-L:M and PA log on the eight day. Physical activity levels (low, moderate and high) and total MET-min/week⁻¹ were calculated and compared to determine if individuals have sufficient energy expenditure during Physical activity. Results: All forty three participants reported high levels of PA on both questionnaires (IPAQ-L: M = 81.4%; GPAQ: M = 67.4%). However, all participants were categorised as low PA with the Sense Wear accelerometer. There was no significant difference in the moderate (IPAQ-L: M 2.3%; GPAQ: M = 18.6%) and low (IPAQ-L: M = 16.3%; GPAQ: M = 14%) levels of PA reported in the IPAQ and GPAQ (p > 0.05). Conclusion: The PA self-assessment instruments (questionnaires) yielded high overestimation in classifying PA level and underestimation in terms of Metabolic Equivalent of Task. Therefore, when classifying people as active or inactive, special attention must be given to the assessment method used. Further study is needed to produce a more accurate subjective measure which is equivalent to objective measures like the accelerometer.

Keywords: Physical activity, Questionnaire, Accelerometer, Nurses
INTRODUCTION

There is rising concern in the global pandemic for physical inactivity due to the lack of attention given to the importance of an active lifestyle [1]. However in Malaysia, the National Health and Morbidity Survey 2015 reported that the overall prevalence of physical activity in adults was 66.5% where males (71.1%) were significantly more active than females (61.7%). There is strong evidence that regular physical activity (PA) is associated with significant physiological and psychological health benefits for individuals of all ages [2]. PA has also been associated with improved chronic and non-communicable diseases such as diabetes, high blood pressure, cardiovascular diseases and cancer [3-6]. The psychological benefits of PA include improved mood, self-esteem and quality of life as well as reduction in symptoms of depression and anxiety [7].

The World Health Organization (WHO) recommends that adults aged 18–64 years should do at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic PA or a combination of moderate- and vigorous-intensity PA per week. Therefore, it is necessary to have an accurate assessment of PA to ensure that individuals participate in adequate PA to gain health benefits [8]. There are various objective and subjective tools and methods available to measure PA. Objective measures include pedometers, accelerometers and heart rate monitors whereas subjective measures are self-report questionnaires, PA logs and diaries. However, all these methods have advantages and disadvantages [9]. The most cost-effective and practical method of measuring PA is by using questionnaires, especially for large scale studies. Questionnaires can provide an estimate of frequency, duration, and intensity of PA. However, they are influenced by the respondent’s capacity to recall past PA behaviour [10-12]. Because of that, individual self-report PA measures are less appropriate for research looking at PA levels because of the susceptibility to information bias and misclassification [13,14]. Self-report measures are generally used to estimate PA characteristics of a population. PA log can be a powerful subjective tool in terms of accuracy and to provide precise data [9]. However, the need to constantly record daily activity at every given point of time is demanding and time consuming. Accelerometers are the most practical and effective compromise between accuracy and feasibility for measuring PA and energy expenditure [15]. However, the limitations of accelerometers include the inability to record non-ambulatory activity, the relative high cost in addition to variability and reliability of different brands. Although there are more than 90 different PA questionnaires, two of most commonly used are the International Physical Activity Questionnaire (IPAQ) and the Global Physical Activity Questionnaire (GPAQ). The IPAQ has two forms: the long form (IPAQ-L) comprises 27 items and the short form (IPAQ-S) which consists of 7 items. The IPAQ-L is designed specifically for population surveillance of PA among individuals aged 15 to 69 years. The IPAQ long and short forms are being used as an evaluation tool in intervention studies for different populations, for example, cancer, diabetes, arthritis and older adults [16-18]. The 16-item GPAQ was designed specifically for surveillance studies in developing countries and has been used to measure a wide range of health-enhancing PA in various countries [10, 19-22].

Both the IPAQ and GPAQ have been translated into different languages (21 languages for IPAQ and 9 languages for GPAQ) including the Malay language [11,12, 19-34]. The on-going challenge in PA assessment research is to identify an accurate and low-cost PA assessment tool that can be used in different cultures and ethnic groups around the world [8, 12, 22, 35]. Although the IPAQ and GPAQ are widely used, studies have
reported that they were not as accurate and reliable as they should be as they were dependent on lifestyle patterns and the capability of the respondents in recalling and answering the questionnaire [2, 36, 37]. Previous studies have reported that the IPAQ showed better reliability and accuracy for persons with stable work patterns compared to persons with more variable PA patterns [20]. The IPAQ-L has been found to overestimate PA levels [2, 13].

Studies have not compared subjective and objective measures between the IPAQ-L, GPAQ, daily PA log and accelerometer. A compilation of all types of available PA questionnaires can be found in the study by Helmerhorst et al. (2012). However, it is unclear how accurate the subjective measures are compared to the accelerometer. Therefore, the purpose of this study was to compare PA levels obtained from the Malay versions of the IPAQ (IPAQ-L: M) and GPAQ (GPAQ: M) with those from a PA log and accelerometer.

METHODS

A cross-sectional method was used in this study. The sample comprised female hospital nurses who had good command of the Malay language. Nurses with physical illness or disabilities that would limit daily physical activities such as walking were excluded from the study. Participants volunteered to take part in this study and provided informed consent prior to participation. This study was approved by the university ethics committee. Sample size was determined based on power analysis. A sample size of 33 was needed for this study to provide an 80% power to detect a significant response in self-report MET-min/week\(^{-1}\) value at \(p < 0.05\). To plan against 30% attrition, we recruited a total of 43 nurses.

Assessment of physical activity by IPAQ and GPAQ

The Malay versions of the IPAQ (IPAQ-L: M; \(r = 0.7 - 0.9\)) and GPAQ (GPAQ: M; \(r = 0.7 - 0.8\)) [10,11] were used. Based on the total amount of PA scores obtained, participants were classified into one of three PA levels (low, moderate or high). For the IPAQ-L: M, the following Kilocalories and Metabolic Equivalent of Task (METs) values were used: walking = 3.3 METs, moderate activity = 4.0 METs, and vigorous activity = 8.0 METs. High PA level is defined as vigorous-intensity activity on at least three days achieving a minimum total physical activity of at least 1,500 MET-minutes/week or seven days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum total PA of at least 3,000 MET-minutes/week. Moderate PA level is classified as five or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum total PA of at least 600 MET-minutes/week. A person who does not meet the high or moderate PA level criteria is classified as low PA.

For the GPAQ: M, METs were calculated based on the following: walking = 4.0 METs, moderate = 4.0 METs and vigorous = 8.0 METs. The MET-min week\(^{-1}\) was calculated as minutes of activity/day \(\times\) days per week \(\times\) MET level. High PA level is defined as vigorous-intensity activity on at least 3 days achieving a minimum of at least 1,500 MET-min week\(^{-1}\) or 7 or more days of any combination of walking, moderate or vigorous intensity activities achieving a minimum of at least 3,000 MET-min week\(^{-1}\). Moderate PA level is defined as 3 or more days of vigorous-intensity activity of at least 20 minutes per day or 5 or more days of moderate-intensity activity or walking of at least 30 minutes per day or 5 or more days of any combination of walking, moderate- or vigorous intensity activities achieving a minimum of at least 600 MET-min week\(^{-1}\). A person who does not meet either the high or moderate PA level criteria falls in this category.

Data cleaning were based on IPAQ and GPAQ analysis guides. Each participant must have a valid response for at least one domain and have no invalid responses for any domains. Data entry which did not meet these requirements were excluded.

Assessment of PA by accelerometer
We used the SenseWear Mini (SWA; BodyMedia, Inc., Pittsburgh, Pennsylvania) accelerometer (software V.7.0, algorithm V.2.2.4) which has been widely used in research [2, 11, 16, 18]. The SWA provides objective information such as PA level, energy expenditure, METs value, and sleep estimation. PA was reported as minutes per day of sedentary time, moderate activity and vigorous activity and as MET-minutes (where 1 MET is equivalent to resting energy expenditure) of moderate-to-vigorous PA (minutes of moderate activity × 4.0 METs + minutes of vigorous activity × 8.0 METs). These specific METs values within the moderate (3.0 – 6.0 METs) and vigorous (> 6.0 METs) intensity ranges were chosen for consistency with the MET values assigned for moderate and vigorous activity in the IPAQ and GPAQ scoring protocol. Anything below these values were considered low PA levels. Kilocalories and METs were converted into kcal/kg/hour. Data cleaning is based on SWA analysis guide which include device must be worn for more than 14 hours a day for seven consecutive days. Device that did not meet the requirements were excluded.

Assessment by PA log

All participants receive a PA log diary to record their daily activity for seven days. Accuracy of reporting in the PA log depended on the participant’s precise recording of daily activities. Activities were converted to the following MET values: walking = 3.3 METs, moderate activity = 4.0 METs and vigorous activity = 8.0 METs. Classification of PA levels was also classified according to similar categories with IPAQ.

Procedure

A cross-over method was used to compare the IPAQ-L: M and GPAQ: M. Participants were randomly divided into two groups. Participant demographic information was collected as to height and weight measurements. Group 1: During the first visit, participants answered the GPAQ:M and given a PA log to record daily activities for a week and the SWA to wear for seven consecutive days except when bathing, showering or participating in water activities. On Day 8, participants returned the SWA and answered the IPAQ-L: M. Group 2: During the first visit, participants answered the IPAQ-L: M and given a PA log book to record daily activities for a week and the SWA to wear for seven consecutive days except when bathing, showering or participating in water activities. On Day 8, participants returned the SWA and answered the GPAQ: M. All questionnaires were self-administered.

Statistical analysis

Data was analysed using SPSS version 20. Descriptive statistics (means and standard deviations) were calculated for all variables. Participants were categorised into three PA categories (low, moderate or high) based on their total PA scores. The PA scores, described as mean METs-min week⁻¹, were used to compare data obtained from the questionnaires, PA log and accelerometer. METs calculations for the IPAQ-L: M and GPAQ: M were based on the respective analysis guides [38,39]. In many previous studies, minutes of PA were used to determine PA levels. We, however, used METs-min/week⁻¹ because energy expenditure is a more reliable and accurate measurement for PA level. This is because time-based work can be easily misconstrued by the intensity on the work performed. Comparison between these four instruments (IPAQ-L: M, GPAQ: M, PA log and SWA) was done using Pearson correlations. Paired sample t-tests were used to determine the mean difference in MET-min week⁻¹ between GPAQ: M, IPAQ-L: M, PA log and SWA. Statistical significance was accepted at p < 0.05. Paired sample t-tests were also used to compare by evaluating equivalency of SWA with IPAQ: M, SWA with GPAQ: M and IPAQ- M with GPAQ: M using difference in mean value of the METs. A Bland-Altman plot was used to determine if there was no significant difference in the level of agreement within the two variables measured. A Bland Altman plot was created with linear regression for IPAQ-L: M versus GPAQ: M for proportional bias.
RESULTS
A sample of 43 female participants aged between 24 to 55 years (44.48 ± 8.38 years) participated in the study. Their mean weight was 71.32 ± 10.91 kg, mean height 155.72 ± 5.71 cm and mean BMI 28.98 ± 4.39. Table 1 shows the descriptive statistics on SWA, GPAQ: M, IPAQ-L: M and PA log.

Table 1: Descriptive Statistics on SWA, GPAQ: M, IPAQ-L: M and PA log

<table>
<thead>
<tr>
<th></th>
<th>SWA</th>
<th>GPAQ: M</th>
<th>IPAQ-L: M</th>
<th>PAL</th>
</tr>
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<tbody>
<tr>
<td>Mean</td>
<td>15818.2</td>
<td>6495.02</td>
<td>7475.06</td>
<td>11256.5</td>
</tr>
<tr>
<td>Std. Dev</td>
<td>1845.83</td>
<td>7304.85</td>
<td>8303.56</td>
<td>3424.29</td>
</tr>
</tbody>
</table>

SWA = SenseWear Accelerometer, GPAQ: M = Global Physical Activity Questionnaire: Malay Version, IPAQ-L: M = International Physical Activity Questionnaire long Form: Malay Version, PAL = Physical activity log

Table 2 (see next page) shows the mean total METs min per week-1 compared using paired sample t-tests. Significant differences were found in the mean MET-min week-1 between IPAQ-L: M with SWA and PA log as well as between GPAQ: M with SWA and PA log (p < 0.05). There was no significant difference between the mean MET-min week-1 between the IPAQ-L: M and GPAQ: M. In addition, standard deviations around the means were substantially greater in IPAQ-L: M and GPAQ: M indicating greater variance in self-reported activity levels. Paired sample t-tests showed significant differences between IPAQ-L: M and SWA, GPAQ: M and SWA, IPAQ-L: M and PA log, GPAQ: M and PA log, SWA and PA log. However, there was no significant difference between IPAQ-L: M and GPAQ: M. Therefore a Bland-Altman plot was created which indicated that there was no proportional bias and there was an agreement between IPAQ-L: M and GPAQ: M.

Table 3 (See next page) shows the comparison of PA levels between GPAQ: M, IPAQ-L: M and SWA. More than half the participants reported high levels of PA on both questionnaires (GPAQ: M = 67.4%; IPAQ-L: M = 81.4%). Participants reported more moderate PA in the GPAQ: M (18.6%) compared to the IPAQ-L: M (2.3%). There were nearly equal numbers of participants who reported low PA (GPAQ: M = 14%; IPAQ-L: M = 16.3%) on both questionnaires. All 43 participants were categorised as low PA based on METs-kcal/kg/hour (1.36 ± 0.17) on the SWA despite having high (15818.21 ± 1845.83) MET-min week-1 values.

Table 4: Pearson Correlation between GPAQ: M, IPAQ-L: M, SSWA & PA log METs-min/week-1

<table>
<thead>
<tr>
<th></th>
<th>GPAQ</th>
<th>IPAQ</th>
<th>SWA</th>
<th>PA log</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation Coefficient (2-tailed)</td>
<td>1</td>
<td>0.214</td>
<td>-0.113</td>
<td>-0.015</td>
</tr>
</tbody>
</table>

SWA = SenseWear Accelerometer, GPAQ: M = Global Physical Activity Questionnaire: Malay Version, IPAQ-L: M = International Physical Activity Questionnaire long Form: Malay Version, PAL = Physical activity log

Figure 1: Bland-Altman Plot on mean difference between GPAQ: M and IPAQ-L: M METs-min/week-1
COMPARING PHYSICAL ACTIVITY LEVELS OF IPAQ, GPAQ WITH ACCELEROMETER

Table 4 shows the correlations between GPAQ: M, IPAQ-L:M, SSWA and PA log METs-min/week\(^{-1}\). The Pearson correlation coefficient revealed a negligible negative correlation \((r = -0.222, p > 0.05)\) between IPAQ-L: M and SWA, a negligible negative correlation \((r = -0.113, p > 0.05)\) between GPAQ: M and SWA, and a positive correlation between SWA and PA log \((r = 0.272, p = 0.077)\) and no significant correlation between IPAQ and GPAQ \((r = 0.214, p > 0.05)\). There is negative correlation between GPAQ and PA log \((r = -0.015, p > 0.05)\) and a positive correlation between IPAQ-L: M and PA log \((r = 0.038, p > 0.05)\).

**DISCUSSION**

This study aimed to find a reliable and accurate subjective measure of PA which is conceptually equivalent to the more accurate objective measure which is the accelerometer. We found that there were no correlations between the IPAQ-L: M and SWA as well as GPAQ: M and SWA. Recent studies have also reported no correlation between the short form of the IPAQ and accelerometer [13,14]. This indicated that both questionnaires were not reliable and accurate when quantifying PA scores in METs-min/week\(^{-1}\).

**Table 2: Paired sample t-test on METs-min week\(^{-1}\) (of SWA, GPAQ: M, IPAQ-L: M and PA log)**

<table>
<thead>
<tr>
<th>Pair</th>
<th>GPAQ - IPAQ</th>
<th>GPAQ - SWA</th>
<th>GPAQ - DMET</th>
<th>IPAQ - SWA</th>
<th>IPAQ – PA log</th>
<th>SWA – PA log</th>
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<td>1</td>
<td>-980.04186</td>
<td>9818.31834</td>
<td>1497.27951</td>
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**Table 3: METs-min week\(^{-1}\) comparison on PA level between GPAQ, IPAQ & SWA**

<table>
<thead>
<tr>
<th>GPAQ PA Level Mean</th>
<th>GPAQ PA Level SD</th>
<th>GPAQ PA Level N</th>
<th>IPAQ PA Level Mean</th>
<th>IPAQ PA Level SD</th>
<th>IPAQ PA Level N</th>
<th>SSWA PA Level Mean</th>
<th>SSWA PA Level SD</th>
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However, there was a weak positive correlation between the IPAQ-L: M and GPAQ: M. Studies which investigated the relationship between the short form of the IPAQ and GPAQ also reported a weak relationship between both measures ($r = .2 - .4$) [11, 12, 40]. This showed that both questionnaires were almost similar in quantifying PA scores using METs-min/week$^1$. In this study, the MET-min/week$^1$ values calculated from both questionnaires underestimated the METs value when compared to the SWA and PA log. This suggests that the participants’ ability to recall the previous week’s PA was less accurate compared to the PA log. The PA log showed a weak correlation with the SWA ($p > 0.05$).

In terms of PA levels, SWA shows that all participants fell into the low PA category based on METs-kcal/kg/hour. Results of METs-kcal/kg/hour on the SWA device showed a mean of $1.36 \pm 0.17$ METs-kcal/kg/hour despite having high ($15818.21 \pm 1845.83$) MET-min week$^1$ values. The cut-off point for moderate PA levels is more than 3.0 METs-kcal/kg/hour and for high PA levels more than 6.0 METs-kcal/kg/hour. However, currently IPAQ and GPAQ do not use METs-kcal/kg/hour to classify PA levels. Both the IPAQ-L: M and GPAQ: M overestimated PA levels when compared to the SWA. This was similar to other studies where healthy adults overestimated their PA by as much as 17% to 67% [10, 22, 23]. This indicated that two subjective measures (IPAQ, GPAQ) were not accurate when compared to the objective measure (SWA). This was also seen in this study where our Bland-Altman plot analysis indicated that GPAQ and IPAQ showed agreement as both questionnaires provide similar scores. When compared to the SWA, the PA log reported more accurate scores than the IPAQ-L: M and GPAQ: M. This indicated that daily recording of PA have shown to be better in providing reliable PA scores compared to both questionnaires which require one week recall. When answering both questionnaires, participants may forget to record short-duration activities, such as active transport, leading to an underreporting of these activities.

Feedback from participants after the study indicated that the GPAQ: M was easier to answer compared to the IPAQ-L: M because the questions were fewer in number and more straightforward. The GPAQ: M was also less time-consuming compared to the PA log. This indicates that the GPAQ:M is more suitable to be used among nurses in this study. However, a limitation of this study is the small sample size which made it difficult to draw a firm conclusion on the accuracy of the subjective versus the objective measures.

### Conclusions

PA self-assessment instruments overestimated PA levels and underestimated METs values. Therefore, when classifying people as active or inactive for clinical purposes, special attention must be given to the assessment method used. Results suggest that there was no significant difference in the accuracy between the IPAQ-L: M and GPAQ: M. Our data suggested that it is important to improve the sensitivity and specificity of the questionnaires especially with Malay speaking participants.

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Author Contributions

GL, SK & MNAM conceived and designed the experiments. GL, SK & MNAM performed the experiments. GL analysed and interpreted the data. GL, SK, MNAM & NAT contributed reagents/materials/analysis tools. GL, SK & MNAM drafted the original manuscript. NAT provided critical revision of manuscript for intellectual content.

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