Pertanika J. Sci. & Technol. 22 (2): 401 - 417 (2014)

SCIENCES & TECHNOLOGY

Journal homepage: http://www.pertanika.upm.edu.my/

Comparison of Physical Activity Prevalence among International Physical Activity Questionnaire (IPAQ), Steps/Day, and Accelerometer in a Sample of Government Employees in Kangar, Perlis, Malaysia

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ABSTRACT

The aim of this study was to compare physical activity prevalence estimates among the International Physical Activity Questionnaire (IPAQ), steps/day, and accelerometer in a sample of government employees in Kangar, Perlis, Malaysia. Ten government agencies in Kangar were randomly chosen, and all employees were invited to participate. A self-administered questionnaire was employed to obtain information on socio-demographic characteristics and a physical activity assessment using the IPAQ. Anthropometric measurements, which include measurements of weight, height, body mass index, percent body fat, waist and hip circumference, were carried out. An accelerometer was used to assess total daily energy expenditure and the number of steps/day. A total of 272 respondents were involved in this study with a response rate of 83.2%. According to IPAQ, accelerometer and steps/day, the majority of the respondents (22.0%, 55.1%, and 77.6%, respectively) were classified as sedentary. The agreement between physical activity level as determined by the accelerometer vs. the IPAQ (Kappa=-0.46 {95% CI -0.384,-0.536}, p=0.238) and the IPAQ vs. steps/day (Kappa =0.037 {95% CI 0.090,-0.016}, p=0.175) was not significant, but the agreement between physical activity level as determined by the accelerometer vs. steps/day was classified as fair (Kappa=0.296 (95% CI 0.392, 0.200}, p<0.001). Our study highlights the need for a valid, accurate, and reliable self-report physical activity assessment tool for Malaysian adults.

Keywords: Prevalence, physical activity measurements, accelerometer, IPAQ, steps/day.

Article history:
Received: 3 January 2012
Accepted: 27 April 2012

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ISSN: 0128-7702

INTRODUCTION

Physical activity is defined as “any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level” (The U.S. Department of Health and Human Services, 2008). Physical activity has been shown to improve health, and the World Health Organization (WHO) recommends that adults aged 18–64 years engage in moderate intensity aerobic physical activity at least 150 minutes per week. Alternatively, they require at least 75 minutes of vigorous intensity aerobic physical activity per week or an equivalent combination of moderate to vigorous intensity activities (World Health Organization, 2011).

One can assess physical activity level using objective methods such as accelerometers, pedometers, and double labelled water, as well as subjective methods such as questionnaires or physical activity diaries. Epidemiological studies often use questionnaires simply because they are lower in cost, easy to administer, and present a smaller burden to respondents. Many studies have used accelerometers to validate data obtained through self-report. Craig *et al*. (2003) studied the use of The Computer Science Application (CSA) motion detectors (accelerometers) in 12 countries to validate the International Physical Activity Questionnaire (IPAQ). Bull *et al*. (2009) used an objective measure (a pedometer and an accelerometer) to validate the Global Physical Activity Questionnaire (GPAQ) over 7 days.

Self-report measures of physical activity usually rely on the participants’ ability to recall, to be honest, and to estimate the time, frequency, and intensity of their activities over the past 7 days. Some findings from the self-report have proved to be overestimations, as compared to objective methods of physical activity assessment. Troiano *et al*. (2008) hypothesised that such overestimations might stem from respondents’ misperceptions/misclassifying of activities (i.e., the type) and underestimations by accelerometers.

One of the self-report instruments used in physical activity assessments is IPAQ. According to Craig *et al*. (2003), IPAQ has reasonable measurement properties for monitoring a population’s physical activity levels with a criterion validity median of about 0.30 among 18 to 65 year old adults from various countries. However, several studies have shown that IPAQ overestimates physical activities by 85% among Vietnamese, 100% among Americans, 170% among Hong Kongers (Lee *et al*., 2011), 165% among New Zealanders (Boon *et al*., 2008), and 247% among cancer patients (Johnson-Kozlow *et al*., 2008). Although IPAQ is regarded as a good measure of the physical activity levels among certain populations such as well-educated respondents, there are studies which have proven that it is less accurate when administered to the population of other groups.

To the authors’ knowledge, no data have been published on the agreement between IPAQ and objective methods of physical activity assessment such as accelerometers among Malaysians in Malaysia, a developing country with an upper-middle income economy (The World Bank Group, 2011). Questionnaires such as IPAQ, GPAQ, and Physical Activity Questionnaire for Older Children (PAQ-C) have been used in population studies in Malaysia to determine the prevalence of physical activity (see for instance, Soo, Wan Abdul Manan & Wan Suriati, 20112; Siti Affira, Mohd Nasir, Hazizi, & Kandiah, 2011; Farah Wahida, Mohd Nasir, & Hazizi, 2011). The validity of these questionnaires has been established among developed nations. Due to the differences in terms of social, economic, and cultural backgrounds, however, researchers need to study the comparability of the physical activity level estimates using IPAQ, steps/day, and accelerometers among Malaysians. Hence, the aim of this study is to compare physical activity level estimates using the IPAQ, steps/day, and accelerometers among a sample of government employees in Kangar, Perlis, Malaysia.

MATERIALS AND METHODS

This study employed a cross-sectional design involving employees from government agencies. A list of government agencies in Kangar, Perlis, Malaysia was obtained from the official website of the state government of Perlis. The sample size for this study was calculated based on the formula by World Health Organization (2008) and data from the National Health and Morbidity Survey III (Institute for Public Health, 2008). The minimum number of the respondents needed for this study was 96. Ten agencies were randomly chosen, and all the employees from the selected agencies were invited to participate in the study (n = 327). Ethical approval for this study was obtained from the Medical Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia. All the respondents were briefed on the study using an information sheet and their written informed consent was obtained.

Inclusion criteria were employment in the selected government agencies in Kangar, Perlis, and age range of 18 to 65 years. Those who were pregnant or with physical disabilities (the ones that limited mobility such as use of a wheelchair, crutches, walking stick, arthritis, etc.) were excluded. Physical disabilities were identified based on the self-reported data obtained from the respondents.

Measures

Demographics and Self-reported Physical Activity

The questionnaire, which is written in the Malay language and self- administered, comprises of two sections. Section A contains socio-economic and demographic characteristics which include occupation, age, date of birth, sex, race, religion, marital status, educational level, monthly income, and number of household members. Section B includes an assessment of physical activity using IPAQ-Short in the Malay language downloaded from the IPAQ website (www.ipaq.ki.se). IPAQ has been validated in studies carried out in several countries (Craig *et al*., 2003). The classification of MET scores for the IPAQ and physical activity classification was based on Sjostrom *et al*. (2005). Total physical activity was calculated based on the total number of days, minutes and intensity of physical activity reported; these were then classified as ‘‘Low’’, ‘‘Moderate’’ or ‘‘High’’ levels of physical activity.

Anthropometric Measurements

Height was measured using a Body Meter (SECA 206, Body Meter, Germany) that was fixed on the wall. The respondents were asked to remove all footwear and head gear. Height was measured to the nearest 0.1 cm, with the respondents standing erect without shoes. Body weight and percentage of body fat were measured using a Tanita Body Composition Analyzer (Tanita

TBF-306, Body Composition Analyzer, Japan) with minimal clothing (and no shoes or socks). Weight was measured to the nearest 0.1 kg. The classification of % body fat was based on Lee and Nieman (2003). Body mass index (BMI) was calculated using a standard formula. The classification of BMI for adults was based on the guidelines by World Health Organization (1998). Waist circumference was obtained by measuring the distance around the smallest area below the rib cage and above the umbilicus (belly button) using a non-stretchable tape measure (World Health Organization, 2008). Waist circumference was measured in centimetres and classified as high risk if it is ≥ 90 cm for males or ≥ 80 cm for females (IOTF/ WHO/IASO, 2000). Respondents' blood pressure was measured by the researcher using Omron Blood Pressure Monitor (IA2, Japan) in a sitting position after 5 minutes resting. The American Heart Association classified hypertension as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90mmHg ratings on each of 2 or more office visits (Chobanian *et al*., 2003).

Accelerometer-Determined Physical Activity

The respondents were instructed to wear the accelerometer (Lifecorder, Suzuken, Japan) for 3 days, 2 weekdays and 1 weekend day. The accelerometer was attached vertically to the waistband of the clothing during waking hours, except when bathing or swimming. The respondents were encouraged not to alter their usual physical activity habits during the 3 days of measurement. The validity and reliability of the Lifecorder accelerometer have been discussed elsewhere (Total energy expenditure r=0.928 P<0.001 Kumahara *et al*., 2004; Total energy expenditure r=0.998 P<0.001 Heng & Hazizi, 2010). Steps/day was also determined by the accelerometer and classified based on Tudor-Locke and Bassett (2004) as follows: sedentary (<5000 steps/day), inactive (5000-7499 steps/day), somewhat active (7500-9999 steps/day), and active (≥ 10,000 steps/day). The accelerometer-determined physical activity level was calculated as the ratio of total energy expenditure (TEE) to basal metabolic rate (BMR). Meanwhile, physical activity level (PAL) was classified according to FAO/WHO/UNU (2004), where the respondents' activity levels were categorised as sedentary (PAL 1.40-1.69), active (PAL 1.70-1.99), or vigorous (PAL 2.00-2.40).

Data Analysis

Data analysis was performed using SPSS package for Windows, version 19. Descriptive statistics such as frequencies, means, percentages, and standard deviations, were used to describe variables like age, BMI, waist circumference, and physical activity level. Pearson's correlation coefficient and kappa statistics are presented in tables. The kappa statistics was used to determine the agreement between the methods used in the study. A statistical probability level of $p< 0.05$ was considered as significant.

RESULTS

The total number of employees from the 10 agencies chosen was 327. All 327 employees were invited to participate in the study, but only 272 agreed (83.2% response rate) to take part. Among the 272 participants, 55% (n=151) were males, and 32.4% (n=88) were between 41 and

50 years of age (mean age = 39±11 years). Table 1 shows the distribution of the respondents by their socio-demographic characteristics. Most of the respondents (46.7%) earned around RM1500-RM2500 monthly. The mean (±s.d.) income was RM1964.98 ± RM986.36 (1USD = RM3.2).

TABLE 1
Distribution of the respondents by selected socio-demographic characteristics

Characteristics	Male (n=151)	Female (n=121)	Total (n=272)
	n (%)	n (%)	n (%)
Sex	151 (55.5)	121 (44.5)	272 (100.0)
Age (years)			
19-30	39 (25.8)	41 (33.9)	80 (29.4)
31-40	29 (19.2)	44 (36.4)	73 (26.8)
41-50	56 (37.1)	32 (26.4)	88 (32.4)
51-62	27 (17.9)	4 (3.3)	31 (11.4)
Income (RM)			
< 1500	43 (28.5)	51 (42.1)	94 (34.6)
1500- 2500	66 (43.6)	61 (50.4)	127 (46.6)
2501- 3500	17 (11.3)	6(5.0)	23 (8.5)
> 3500	25 (16.6)	3 (2.5)	28 (10.3)
Occupation			
Professional	31 (20.5)	4 (3.3)	35 (12.8)
Administrative/clerical	67 (44.4)	110 (90.9)	177 (65.1)
General Assistant	53 (35.1)	7(5.8)	60 (22.1)
Marital Status			
Single	26 (17.2)	22 (18.2)	48 (17.7)
Married	122 (80.8)	94 (77.7)	216 (79.4)
Divorced/ Widowed	3 (2.0)	5 (4.1)	8 (2.9)
Education Level			
Primary School	6 (4.0)	1 (0.8)	7 (2.5)
SRP/ PMR/ LCE	29 (19.2)	15 (12.4)	44 (16.2)
SPM/ MCE/ O Level	36 (23.8)	41 (33.9)	77 (28.3)
STPM/ HSC/ A Level	20 (13.2)	30 (24.8)	50 (18.4)
Diploma/ Degree	60 (39.8)	34 (28.1)	94 (34.6)

SRP - Sijil Pelajaran Malaysia
PMR - Penilaian Menengah Rendah
LCE - Malaysia Lower Certificate of Education
SPM - Sijil Pelajaran Malaysia
MCE - Malaysian Certificate of Education
O Level - Ordinary Level General Certificate of Education (GCE)
STPM - Sijil Tinggi Pelajaran Malaysia
HSE - Higher Certificate of Education
A Level - Advanced Level General Certificate of Education (GCE)

In term of occupation, most of the respondents 65.1% (n=171) worked in administrative or clerical positions such as administration assistant. Only 12.8% (n=35) worked in professional positions. Among the respondents, 79.4% (n=216) were married, with 34.6% (n=94) holding either diploma or degree qualifications.

Table 2 shows the distribution of the respondents by BMI, waist circumference, waist-hip ratio, percentage of body fat and blood pressure. More respondents were classified as overweight (37.5%) than having a normal weight (34.9%). The overweight group contained more male (42.4%) than female respondents (31.4%), while 21.7% of the respondents were classified as obese. Only 5.9% of them were underweight. Meanwhile, 57.0% and 56.2% of the male and female respondents were classified as at risk based on their waist circumferences.

TABLE 2
Distribution of the respondents by BMI, waist circumference, waist-hip ratio, percentage of body fat and blood pressure

Indicators	Cut-off point	Male (n=151)	Female (n=121)	Total (n=272)
		n (%)	n (%)	n (%)
BMI (kg/m^2)				
Underweight	<18.5	4 (2.7)	12 (9.9)	16 (5.9)
Normal	18.5–24.9	57(37.7)	38 (31.4)	95 (34.9)
Overweight	25.0–29.9	64 (42.4)	38 (31.4)	102 (37.5)
Obese	30.0–>40.0	26 (17.2)	33 (27.3)	59 (21.7)
Waist circumference (cm)				
Acceptable	Male:<90 Female:<80	65 (43.0)	53 (43.8)	118 (43.4)
At risk	Male:≥90 Female: ≥80	86 (57.0)	68 (56.2)	154 (56.6)
Waist-hip ratio				
Acceptable	Male: <0.9 Female:<0.8	70 (46.4)	58 (47.9)	128 (47.1)
At risk	Male: ≥0.9 Female: ≥0.8	81 (53.6)	63 (52.1)	144 (52.9)
Fat Percentage (%)				
Acceptable	Male: 6-24 Female: 9-31	58 (38.4)	42 (34.7)	100 (36.8)
Unhealthy	Male: ≥25 Female: ≥32	93 (61.6)	79 (65.3)	172 (63.2)
Systolic blood pressure (mmHg)				
Normal	<140	69 (45.7)	77 (63.6)	146 (53.7)
Elevated	≥140	82 (54.3)	44 (36.4)	126 (46.3)
Diastolic blood pressure (mmHg)				
Normal	<90	106 (70.2)	87 (71.9)	193 (71.0)
Elevated	≥90	45 (29.8)	34 (28.1)	79 (29.0)

In terms of waist-hip ratio, more male respondents (53.6%) were categorised as at risk than the female respondents (52.1%), although the difference between the genders was not significant. For the percentage of body fat, most respondents were classified as having an unhealthy percentage of body fat: 61.6% and 65.3% for the male and female respondents, respectively. The percentage of the respondents with elevated systolic blood pressure was also higher in males as compared to females. However, the percentage of elevated diastolic blood pressure was almost similar between both genders.

Table 3 shows the distribution of the respondents' physical activity level as measured by IPAQ, accelerometer, and steps/day. Using IPAQ, most of the respondents (47.7% of males and 66.9% of females) were found to having a moderate level of physical activity, whereas only 22.1% and 21.7% were categorised as having low and high levels of physical activity, respectively. Using the accelerometer, most of the respondents (55.1%) were classified as sedentary, and only 8.0% were classified as having a vigorous level of physical activity. Similarly, based on the number of steps/day, most of the respondents (77.6%) were classified as sedentary and low active. Only 7.7% were classified as leading active lifestyles.

TABLE 3
Distribution of the respondents by gender and physical activity level as assessed by accelerometer, IPAQ, and steps/day

Instruments	Cut off point	Male (n=151)	Female (n=121)	Total (n=272)
		n (%)	n (%)	n (%)
Accelerometer-determined physical activity level				
Sedentary	1.40-1.69	75 (49.7)	75 (62.0)	150 (55.1)
Active & Moderately active	1.70-1.99	61 (40.4)	39 (32.2)	100 (36.8)
Vigorous	2.00-2.40	15 (9.9)	7 (5.8)	22 (8.1)
IPAQ				
Low	<600 MET-min/week	26 (17.2)	34 (28.1)	60 (22.0)
Moderate	600-2999 MET-min/week	72 (47.7)	81 (66.9)	153 (56.3)
High	≥3000 MET-min/week	53 (35.1)	6(5.0)	59 (21.7)
Steps/day				
Sedentary & Low active	<7500 steps	105 (69.5)	106 (87.6)	211 (77.6)
Somewhat Active	≥7500-9999 steps	27 (17.9)	13 (10.7)	40 (14.7)
Active	≥10000 steps	19 (12.6)	2 (1.7)	21 (7.7)

Table 4 shows the distribution of physical activity levels as measured by steps/day, and IPAQ according to accelerometer measured PAL. The agreement between the activity levels, as determined by the accelerometer vs. IPAQ and IPAQ vs. steps/day, was not significant but the agreement between the activity levels as determined by the accelerometer vs. steps/day was significant and classified as fair (Kappa=0.296, $p<0.001$). The percentage of agreement between steps/day and accelerometer-determined physical activity level was 64% and those between physical activity level as determined by the accelerometer vs. IPAQ, and IPAQ vs. steps/day were around 30%.

TABLE 4
Distribution of physical activity levels as measured by steps/day and IPAQ according to accelerometer-measured PAL

	Accelerometer-determined physical activity level					
	Sedentary	Active or moderately active	Vigorous	Total	Kappa	p
	n (%)	n (%)	n (%)	n (%)		
Steps/Day						
Sedentary & low active	136 (50.0)	69 (25.4)	6 (2.2)	211 (77.6)	0.296	0.00
Somewhat Active	12 (4.4)	25 (9.2)	3 (1.1)	40 (14.7)		
Active	2 (0.7)	6 (2.2)	13 (4.8)	21 (7.7)		
Total	150 (55.1)	100 (36.8)	22 (8.1)	272 (100.0)		
IPAQ						
Low	29 (10.7)	25 (9.2)	6 (2.2)	60 (22.0)		
Moderate	90 (33.1)	52 (19.1)	11 (4.0)	153 (56.3)	0.460	0.24
High	31 (11.4)	23 (8.5)	5(1.8)	59 (21.7)		
Total	150 (55.1)	100 (36.8)	22 (8.1)	272 (100.0)		
	IPAQ					
	Low	Moderate	High	Total		
Steps/Day[3]						
Sedentary & Low active	49 (18)	120 (44.1)	42 (15.4)	211 (77.6)		
Somewhat Active	5 (1.8)	25 (9.2)	10 (3.7)	40 (14.7)	0.037	0.18
Active	6 (2.2)	8 (2.9)	7 (2.6)	21 (7.7)		
Total	60 (22.0)	153 (56.3)	59 (21.7)	272 (100.0)		

The percentage of agreement and Kappa statistics were further calculated and compared across two factors: indices of obesity and socio-demographic factors (see Table 5). Indices of obesity include BMI, waist circumference, and percentage of body fat, whereas socio-demographic factors were sex, age, and educational level. The agreement between physical activity as determined by steps/day vs. the accelerometer was significant across all indicators of obesity and socio-demographic factors, with the percentage of agreement ranging from 76.2% to 43%. The percentage of agreement was higher among the overweight/obese (vs. those with a normal weight), those with abdominal obesity (vs. those with a normal waist circumference), those with a higher percent body weight (vs. those with a lower percent body weight), females vs. males, and younger respondents (vs. older respondents). The agreement between physical activity levels as determined by the accelerometer vs. IPAQ and IPAQ vs. steps/day was statistically insignificant across all the indicators of obesity and socio-demographic characteristics.

TABLE 5

Kappa statistics, p value, and percentage of agreement between physical activity levels as measured using an accelerometer vs. the IPAQ, IPAQ vs. steps/day, and an accelerometer vs. steps/day and selected obesity indices and socio-demographic characteristics.

Characteristics	Accelerometer vs. Steps/day {Kappa (95% CI); p value; % of agreement}	Accelerometer vs. IPAQ {Kappa (95% CI); p value; % of agreement}	IPAQ vs. Steps/day {Kappa (95% CI); p value; % of agreement}
Sex			
Male	K=0.326 (0.451, 0.201); p=0.00; 55.0%	K=-0.080 (0.014, -0.174); p=0.101; 25.8%	K=0.012 (0.088, -0.064); p=0.756; 25.8%
Female	K=0.216 (0.361, 0.071); p=0.001; 66.9%	K=-0.007 (0.115, -0.129); p=0.909; 38.8%	K=0.041 (0.108, -0.026); p0.272; 34.7%
Education			
Lower	K=0.338 (0.477, 0.199);p=0.00; 63.3%	K=0.022 (0.136, -0.092); p=0.699; 37.5%	K=0.036 (0.124, -0.052); p=0.419; 26.4%
Upper	K=0.239 (0.372, 0.106); p=0.000; 64.6%	K=-0.110 (-0.006, -0.214); p=0.037; 26.4%	K=0.030 (0.095, -0.035);p=0.359; 29.2%
Age			
≤40 years	K=0.315 (0.462, 0.168); p=0.00; 70.6%	K=-0.005 (0.089, -0.099); p=0.916; 31.4%	K=0.021 (0.094, -0.052); p=0.555; 28.8%
>40 years	K=0.274 (0.394, 0.154); p=0.00 ; 55.7%	K=-0.097 (0.021, -0.215); p=0.127; 31.9%	K=0.057 (0.139, -0.025); p=0.175; 31.1%
Physical Activity Level	K =0.296 (0.392, 0.200), p=0.000; 72.8%	K=-0.46 (-0.384, -0.536); p=0.238; 31.6%	K=0.037 (0.090, -0.016), p=0.175; 29,8%
BMI			
Normal weight	K=0.197 (0.301, 0.093); p=0.00; 46.8%	K=-0.09 (0.124, -0.142); p=0.195; 34.2%	K=0.021 (0.109, -0.067); p=0.618; 38.7%
Overweight/Obese	K=0.417 (0.568, 0.266); p=0.00; 74.3%	K=0.001 (0.085, -0.083);p= 0.974; 30.4%	K=0.045 (0.116, -0.026); p=0.237; 29.7%
Waist Circumference			
Acceptable	K=0.204 (0.318, 0.090); p=0.00; 49.2%	K=-0.036 (0.091, -0.163); p=0.584; 36.4%	K=0.007 (0.097, -0.083); p=0.814; 28.8%
At risk	K=0.404 (0.555, 0.253); p=0.00; 75.3%	K=-0.037 (0.047, -0.121); p=0.393; 27.9%	K=0.059 (0.124, -0.006); p=0.093; 30.5%
Percent Body Weight			
Acceptable	K=0.178 (0.290, 0.066);p=0.00; 43%	K=-0.116 (0.019, -0.251); p=0.11; 32%	K=0.004 (0.102, -0.094); p=0.925; 29%
High	K=0.413 (0.554, 0.272); p=0.00; 76.2%	K=0.014 (0.090, -0.062); p=0.734; 31.4%	K=0.055 (0.118,-0.008); p=0.104; 30.2%

Correlation tests were also performed (see Table 6). The results indicated that the accelerometer-determined physical activity was significantly associated with that determined by steps/day (r=0.354, p=0.00) but not significantly associated with that determined by IPAQ (p=0.531). However, the physical activity level as determined by IPAQ was correlated significantly with that determined by steps/day (r=0.131, p=0.00). The relationship between accelerometer-determined physical activity level and indices of obesity such as waist circumference, hip circumference, percentage of body fat, and BMI was stronger than the correlation observed between the physical activity level as determined by IPAQ and steps/day with the same indicators. In terms of indices of obesity and blood pressure, the physical activity level determined by IPAQ was significantly correlated with waist circumference, waist-hip ratio, and percentage of body fat. Physical activity level, as determined by steps/day, was significantly correlated with percentage of body fat, but physical activity level determined by the accelerometer was significantly associated with almost all indicators of obesity and blood pressure.

TABLE 6
Correlation matrices of relationship between IPAQ, accelerometer determined physical activity, steps/day, indices of obesity, blood pressure and selected indicators of socio-demographic characteristics

	IPAQ	Steps/day	Accelerometer
IPAQ	1*	0.131*	
Steps/Day	0.131*	1*	0.354*
Accelerometer		0.354*	1*
Age			0.213*
Income		-0.139*	
Education		-0.180*	
BMI			-0.580*
WHR	0.163*		
Waist Circumference	0.170*		-0.417*
Hip Circumference			-0.528*
Percent body fat	-0.145*	-0.147*	-0.537*
Systolic blood pressure			
Diastolic blood pressure			-0.185*

*p<0.05

DISCUSSION

The agreement between the subjective methods of physical activity assessment such as IPAQ and objective methods (use of accelerometers, pedometers, and double labelled water) has been reported in many studies (Craig *et al*., 2003; Bull *et al*., 2009; Boon *et al*., 2010; Maddison *et al*., 2007). However, the majority of these studies were carried out among the Western populations. Some studies were carried out among the Asian populations such as in Hong Kong (Lee *et al*., 2011), Singapore (Nang *et al*., 2011) and Vietnam (Lachat *et al*., 2008), but not among Malaysians.

According to the World Bank Group (2011), the gross national income (GNI) for Malaysia was USD7769, while the adult literacy rate (percentage of literate people aged 15 and above) was 92%. In this study, all of the respondents worked in government agencies, almost half of them received a monthly income of RM1500-2500 (or USD6000-10000 per year), and 53% had received at least 18 years of formal education. The prevalence of overweight (37.5%), obesity (21.7%), and abdominal obesity (56.5%) was high in this study. According to the National Health and Morbidity Survey III, the prevalence of overweight and obesity among adults 18 years and above in Malaysia was 29.1% and 14.01%, respectively (Institute for Public Health, 2008).

Previous studies reported that among a sample of respondents in Universiti Putra Malaysia, the prevalence of them who were overweight was 31.9% for males and 26.5% for females, while the total prevalence of obesity was 16.1% (Siew *et al.*, 2010). Meanwhile, a study among a group of security guards and their spouses at the University of Malaya, Kuala Lumpur, also showed a high prevalence (64%) of overweight and obese respondents (Moy & Atiya, 2003).

Based on IPAQ classification, 22% of the respondents were engaged in low level of physical activity. This prevalence of low physical activity is apparently lower than the national prevalence, which is 43.7% in 2006 (Institute for Public Health, 2008). The difference might be due to differences in the study populations, since our study focused on workers aged 18-65 years in a specific state, whereas in the National Health and Morbidity Survey III, the figure reported covered the entire population of Malaysia aged 18 and above. However, the prevalence of low levels of physical activity in the national study was lower compared to the data gathered using the accelerometer (55.1%) and steps/day (77.6%). These might be due to the differences in the instrument used for assessing the respondents' level of physical activity.

In Malaysia, the prevalence of physical inactivity, as measured using a questionnaire based on occupation, was higher among the unemployed group (60.8%), housewives (54.5%), craft and clerical workers (47.3%), senior officials and managers (46.3%), and professionals (46.2%) (Institute of Public Health, 2008). Among a sample of working women in Petaling Jaya, 28.8% of them were found to have low physical activity levels (Siti Affira *et al*., 2011). A low prevalence of adequate exercises (13.8%) was also shown amongst a group of security guards and their spouses at the University of Malaya, Kuala Lumpur (Moy & Atiya, 2003).

The prevalence of physical inactivity by state in Malaysia was higher (more than 50%) in Selangor and Kuala Lumpur, but lowest in Pahang (31.4%) and Terengganu (32.3%), (Institute of Public Health, 2008). On the other hand, among the respondents in Greece, Pitsavos *et al.* (2005) reported physically active people as compared to sedentary among those in higher occupation skills and were more likely to live in rural areas ($p < 0.05$). Another study among adults aged 45 to 68 years in France revealed that subjects aged ≥60 years and women with higher education levels or living in rural areas as more likely to be meeting the recommended physical activity levels (Bertrais *et al.*, 2004).

Accelerometers and pedometers have been used in many studies to validate the physical activity assessment techniques using questionnaires such as in the study by Craig *et al*. (2003) where accelerometer was used to access the validity of IPAQ and the work of Bull *et al*. (2009) where a pedometer was utilized to validate GPAQ. Both the objective techniques used in these studies were compared against the questionnaires data to measure the physical activity (pedometer vs. GPAQ pooled $\rho = 0.31$, $p < 0.01$; IPAQ vs. accelerometer pooled $\rho = 0.33$, 95% CI 0.26–0.39). In our study, the prevalence of moderate physical activity varied according to the assessment techniques used. The prevalence of moderate physical activity was lowest if it was assessed based on steps/day (14.7%) as compared to the physical activity assessments using the accelerometer (36.8%) and IPAQ (56.3%).

Based on some previous studies, the correlation between physical activity level assessments using IPAQ and accelerometer varied across populations. The correlations between these two techniques ranged between -0.12 and 0.57 in a study by Craig *et al*. (2003), indicating variability in the validity of these instruments across populations. The study had a pool correlation of 0.30. The researchers concluded that IPAQ is a valid tool for assessing physical activity levels in surveillance studies. However, in a study by Johnson-Kozlow *et al*. (2006), IPAQ overestimated physical activity levels by up to 247% (as compared to physical activity levels determined using the accelerometer).

In our study, the percentage of agreement between physical activity levels determined by using the accelerometer vs. IPAQ and IPAQ vs. steps/day was around 30%. However, this agreement was not significant based on Kappa statistics. This result supports the conclusions of a recent study by Grimm *et al*. (2011) who found that the overall percentage of agreement was 44.8%. In contrast, a study by Lachart *et al*. (2008) showed that the agreement between physical activity levels, as determined by IPAQ and the accelerometer, was not significant among rural respondents (percentage of agreement = 32.9%; kappa = 0.00; $p = 0.51$) but it was significant among urban respondents (percentage of agreement = 47.9%; kappa = 0.22; $p < 0.0015$), which might be due to the differences in the respondents' socio-demographic characteristics. These results showed that physical activity levels could not be estimated accurately using this questionnaire for all populations.

As reported by Ainsworth *et al*. (2006), the disagreement between physical activity assessments using different questionnaire methods might be due to the differences in understanding the questionnaire among different demographic groups. The differences might also be due to people's tendency to over-report when a self-report questionnaire was used (Rzewnicki, Auweele, & Bourdeaudhuij, 2003). Furthermore, the classification of physical activity levels as sedentary, moderate, or vigorous is rather subjective. This classification may be interpreted differently by the participants based on certain factors such as age, educational level, and other environmental factors. For example, vigorous activity may be interpreted differently by younger groups as compared to the elderly and also people living in rural areas who are used to working and using a lot of energy such as those in the agriculture sector, who may interpret vigorous activity differently than urban executives.

Our study focused on the workers at government agencies in one Malaysian state. Therefore, in terms of socio-demographic characteristics such as educational and income level, our study can not be generalized to the whole Malaysian population. Differences in scoring protocols may also contribute to the differences in the physical activity levels observed in this study. For example, steps/day is an assessment of physical activity levels using walking only. In contrast, IPAQ and accelerometer take into account other activities as well. Nonetheless, accelerometer is often used as a point of comparison for self-report questionnaires such as in the studies of Craig *et al*. (2003), Bull *et al.* (2009), and Grimm *et al.* (2011).

As stated in other studies, accelerometer contains several inherent limitations that contribute to the underestimation of true physical activity levels. For example, accelerometer cannot measure upper body activities such as walking with a load and lifting, which may contribute to inaccuracy in its assessment of level of physical activity (Welk, 2002). Additionally, accelerometers cannot measure activities such as swimming because accelerometers are not waterproof. Further, accelerometers will not accurately measure activities that lack significant acceleration of the hip (e.g. cycling). On the other hand, as many researchers have shown, studies tend to overestimate physical activity levels when questionnaires are used in the assessment (Lee *et al*., 2011).

The results of this study are in line with those of a prospective birth cohort study in Pelotas, Brazil, which showed that the accelerometer-determined physical activity was longitudinally and inversely associated with diastolic blood pressure. Self-reported physical activity was not related to blood pressure and both methods of physical activity assessments were unrelated to systolic blood pressure (Hallal *et al*., 2011). However, as reported by Hedayati, Elsayed and Reiley (2011) in their review paper, there are still inconsistent results on the effects of exercises on blood pressure.

Our findings showed that IPAQ, steps per day, and accelerometer were significantly and negatively correlated with the percentage of body fat. Other studies have also reported significant associations between physical activity measures by questionnaire and accelerometer (questionnaire = -1.93, $p < 0.001$; accelerometer = -1.06, $p = .001$) with the percentage of body fat (Hearst *et al*., 2012). However, the results of the prospective study between objectively measured physical activity and fat mass suggest no association between these two variables (Wilks *et al*., 2011).

The correlation between energy expenditure as measured by IPAQ and body weight indices in this study was significant for waist circumference and percentage of body fat. However, the correlations were found to be stronger between the indices of obesity and accelerometer-determined physical activity. More parameters were significantly correlated to accelerometer-determined physical activity than to assessments using IPAQ or steps/day. The relationship between body weight indices and physical activity levels is still controversial (Cook & Schoeller, 2011). The results of this study showed that accelerometers were better correlated to physical activity levels than the questionnaire data.

Meanwhile, the relationship between energy expenditure, as measured by IPAQ and accelerometer-determined physical activity, was not significant in this study. The relationship between physical activity level, as determined by steps/day and IPAQ, was weak but significant. Other studies comparing objective method vs. IPAQ produced mixed results. Lee *et al*. (2011), Lachat *et al*. (2008), and Nang *et al*. (2011) showed a weak relationship [correlation (r) of 0.10-0.37] between IPAQ and accelerometer-determined physical activity but other studies (Hagstromer *et al*., 2006; Craig *et al*., 2003) showed stronger associations [correlation (r) of 0.55-0.67].

One must interpret the results of this study carefully. The measurement using IPAQ was done before using the accelerometer. Therefore, the two assessment methods were not used simultaneously to measure the same period and thus, the same components of physical activity. The measurement using the accelerometer was done based on 2-week days and one-weekend day, whereas the IPAQ measurement used a 7-day recall technique. Trost *et al*. (2005) suggested that a 3- to 5-day period is adequate for assessing adults' physical activity using an accelerometer. A 7-day recall technique used with IPAQ is common for measuring habitual physical activity using questionnaires. Both of the above techniques are usually used to describe habitual physical activity levels for a population within a stated timeframe. Other researchers such as Lee *et al*. (2011) also confirmed the validity of using IPAQ and accelerometer during non-concurrent periods to determine physical activity levels.

The agreement of the methods used for physical activity assessments among the participants in Malaysia should be studied further. Any result would require a careful interpretation. Additionally, such studies should use concurrent assessments of physical activities using the same instruments utilized in this study and a larger number of respondents from a wider variety of socioeconomic backgrounds.

CONCLUSION

Based on the physical activity levels obtained using the accelerometer and steps/day, the majority of the respondents in our study were sedentary. However, the prevalence of sedentary lifestyles was lower when activity levels were assessed using IPAQ. The agreement between physical activity level as determined by the accelerometer vs. IPAQ and IPAQ vs. steps/day was low and not significant.

ACKNOWLEDGEMENTS

This study was funded by the Ministry of Science, Technology and Innovation, Malaysia (Grant No: 5450422) and the National Institute of Health and Nutrition Japan.

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