



# Examination of the Applicability of the Physical Activity Questionnaire from European Prospective Investigation into Cancer and Nutrition Study in the Hong Kong Chinese Population

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## Abstract

This study assessed the applicability of a four-level physical activity index, developed from the European Prospective Investigation into Cancer and Nutrition (EPIC) study, to rank Hong Kong Chinese according to their physical activity. 197 healthy participants were interviewed with the EPIC physical activity questionnaire (EPIC-PAQ) and the Hong Kong Physical Activity Questionnaire (HKPAQ). Basal Metabolic Rate (BMR) was measured using indirect calorimetry and Total Energy Expenditure (TEE) was estimated using the HKPAQ. Physical activity ratio was calculated as a ratio of estimated TEE to measured BMR. The four-level physical activity index, namely inactive, moderately inactive, moderately active, and active, derived using the EPIC-PAQ was compared with the corresponding physical activity ratio. Reproducibility of the EPIC-PAQ was assessed with participants completed the EPIC-PAQ twice with at least 14-day interval. There was significant trend across the physical activity index with the calculated physical activity ratio. Participants with higher physical activity ratio were categorized with physical activity index ( $r_s=0.205$ ,  $p=0.004$ ). The reproducibility of the EPIC-PAQ was high (weighted kappa = 0.7,  $p<0.0001$ ). The physical activity index derived by the EPIC-PAQ may be a reasonable measure to rank the physical activity level of Hong Kong Chinese.

**Keywords:** Questionnaire; Physical activity; Chinese

## Introduction

During the past few decades a growing interest in the relationship between physical activity and the occurrence of chronic diseases has developed. Lack of physical activity has been associated with a variety of diseases [1,2]. The methods commonly used to assess physical activity or energy expenditure, especially in clinical research, are not always appropriate for large epidemiological studies. For example, Doubly Labeled Water (DLW) technique is regarded as the gold standard for assessing energy expenditure in real life [3], it is however too time-consuming, complex and too expensive for use in large epidemiological studies. Heart Rate (HR) monitoring also requires undisturbed minute-by-minute HR recording during a period of at least 3 days and requires calibration procedure [4].

The assessment method in large-scale epidemiological study should be reproducible, valid, user-friendly and inexpensive. As a result, questionnaire methods are most frequently used due to their low cost, adaptability, ease of administration which reduces participants and researchers burden. International Physical Activity Questionnaire (IPAQ) was one of the most widely used questionnaires in these two decades and it was a long questionnaire with 27 items. Another Global Physical Activity Questionnaire (GPAQ) was developed under the auspices of the World Health Organization using the experiences of the IPAQ instrument and research [5] but it still comprises 19 questions which was time-consuming to complete. This problem of feasibility led to the development of shorter PAQ. A short IPAQ was developed, however, this version had a 50% over-estimation of physical inactivity relative to the long version because less activities were being reported and it lacks specific domain estimates as in the long version [6].

Another short questionnaire was developed by EPIC with the aim being to rank participants in terms of their physical activity [7,8]. It was a much simpler questionnaire with only four questions which was easy to complete. These questions were based on a more extensive

questionnaire designed to measure absolute TEE, that was validated in EPIC studies [9,10]. It focused on activity in the course of the past year. During the course of the pilot study, they decided to change the goal of measuring physical activity from estimating exact energy expenditure to ranking subjects according to physical activity level which resulted in the present short EPIC-PAQ. The questions included in this short questionnaire were extracted from the original validated questionnaire. A simple four-level Physical Activity Index (PAI) was derived by combining specific domains together from occupational activities, time participated in recreational activities and transportation. The four-point PAI derived indicates the relative activity level of participants, and is simple and easy to comprehend especially where a simple global index of activity is required than a final score usually resulted from other questionnaires [10]. Therefore, the present study aimed to assess its reproducibility and applicability to the local Chinese population by comparing the derived PAI from the EPIC questionnaire with the estimated physical activity ratio (PAR) derived from a combination of the local physical activity questionnaire and indirect calorimetry.

## Methods

### Participants

Healthy volunteer participants (n=197) were recruited through

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posters at the university campus and the university fitness room, and the webpage of The Centre for Nutritional Studies of The Chinese University of Hong Kong. Eighty five males (47.9±19.4y, 21-80y) and 112 females (46.2±18.1y, 19-83y) were interviewed. Written informed consent was obtained from all participants. The study was approved by the Clinical Research Ethics Committee of The Chinese University of Hong Kong.

### Anthropometric data

Height and weight were measured in light clothing to the nearest 0.1 cm and 0.1 kg respectively and body fat percentage was obtained using a standard impedance technique (Tanita, Tokyo, Japan, TBF-410). Body mass index (BMI) was calculated as body weight in kg / (height in m)<sup>2</sup>. Waist circumference (WC) was taken as the mid-point between the lower costal margin and the level of the anterior superior iliac crest. Hip circumference (HC) was measured at the level of the greater trochanter. Waist circumference and hip circumference were both measured to the nearest 0.1 cm. Waist-to-hip ratio (WHR) was calculated as the waist circumference divided by the hip circumference.

### The Hong Kong physical activity questionnaire (HKPAQ)

We used the HKPAQ that have been validated in the previous study. The HKPAQ was developed based on the Yale Physical Activity Survey (YPAS) questionnaire [11] (Appendix 1). The HKPAQ was applicable to adults of a wide age range including a broad range of activities covering occupational activities, household chores, sport and leisure time activities, as well as time spent sleeping and sitting. Each activity in the HKPAQ has its corresponding energy intensity code (kcal/min) - the energy (kcal) spent in that particular activity for one minute based on published databases [12-14]. By multiplying the energy intensity code with the time interval (min) and frequency, the energy expended in that particular activity over a week can be obtained. Hence, the daily total energy expenditure can be estimated (i.e. estimated TEE) by summing up the energy expended in all activities.

### The EPIC physical activity questionnaire (EPIC-PAQ)

Details of the EPIC-PAQ were described elsewhere [8,10]. In brief, the questionnaire consists of four physical activity questions referring to occupational activities and recreational activities during the past year. The first question is a four-point, mutually exclusive, ordered category concerning occupational activities, namely sedentary, standing, physical, and heavy manual. Sedentary occupation refers to jobs spending most of the time sitting such as in office. Standing occupation means spending most of the time standing or walking without intense physical effort (e.g. shop assistant, hairdresser, guard, etc.) Physical work involves some physical effort including handling of heavy objects and use of tools (e.g. plumber, cleaner, nurse, sports instructor, electrician, carpenter, etc.) Heavy manual work involves very vigorous physical activity including handling of very heavy objects (e.g. docker, bricklayer, construction work, etc.) The second question refers to the amount of time spent in hours per week for summer and winter separately in each of the following recreational activities: walking, cycling, gardening, do-it-yourself, physical exercise and housework in the past year. The third question asks whether any of the activities in question 2 were engaged in such that it caused sweating or faster heartbeat. The last question asks about stair climbing. A simple four-level PAI, namely inactive, moderately inactive, moderately active, and active, is derived by combining occupational activities together with time participated in recreational activities based on the first two questions (Appendix 2).

Due to obvious lifestyle differences between Hong Kong Chinese and the British population in the EPIC-Norfolk study, the original EPIC-PAQ was modified to suit for the local context (Appendix 2). Two entries for recreational activities in the second question of the original EPIC-PAQ were excluded, i.e., gardening and do-it-yourself. The housework item in the second question of the original questionnaire was also omitted because infrequent low-intensity activities are always reported with less accuracy in physical activity questionnaires [15]. Since cycling is not so common as a transport mean in Hong Kong comparable to Europe, it was combined with walking including to work and during leisure time in question 2.

To assess the reproducibility of the modified EPIC-PAQ, 175 participants were interviewed in random order by the same interviewer and asked to complete the questionnaire twice with at least 14-day interval.

### Measurement of BMR & calculation of PAR

BMR was determined in participants after an overnight fast of more than 10 hours by indirect calorimetry using a  $V_{max}$  29 metabolic monitor (Sensor Medics, Conshohocken, USA). Participants were lying comfortably in the supine position and rested for at least 15 minutes before measurement. The whole measurement duration lasted for roughly 25 minutes. The energy expenditure was determined from the rate of oxygen consumption and carbon dioxide production. Readings from the first five minutes were discarded. An average was taken from the subsequent readings of at least 15 minutes of steady state, and was used for BMR calculation by the following formula.

Measured BMR (kcal/day) = 5.5 × oxygen consumption in ml/min (STPD) + 1.76 × carbon dioxide production in ml/min (STPD) - 1.99 × urinary nitrogen excretion in g/day. (STPD: standard temperature and pressure, dry gas)

For each participant, the PAR was calculated as the ratio of the estimated TEE from the HKPAQ to the measured BMR and it was used to indicate the physical activity level of the subjects after normalization of TEE for BMR.

### Statistical analysis

Data analysis was performed using SPSS version 16.0 (SPSS Inc., Illinois, US). Normality of the data was checked. The independent two sample t-test was used to compare anthropometric data between male and female, and physical activity patterns between the present study and other local studies. The Mann-Whitney U test was used to compare ordinal data of PAI between sexes. The Spearman rank order rho correlation was used to examine the correlation between physical activity levels assessed according to the PAI of the modified EPIC-PAQ and the PAR calculated as the ratio of the estimated TEE from the HKPAQ to the measured BMR.

PAI	Label	Description
1	Inactive	Sedentary job and no recreational activity
2	Moderately Inactive	Sedentary job with <0.5 h recreational activity per day or Standing job with no recreational activity
3	Moderately Active	Sedentary job with 0.5-1 h recreational activity per day or Standing job with 0.5 h recreational activity per day or Physical job with no recreational activity
4	Active	Sedentary job with >1 h recreational activity per day or Standing job with >0.5 h recreational activity per day or Physical job with at least some recreational activity or Heavy manual job

**Table 1:** Interpretation of the four levels of physical activity index (PAI) in the EPIC-physical activity questionnaire.

The reproducibility of the modified EPIC-PAQ was assessed by calculating the Cohen's weighted kappa statistics for the four-category PAI from the baseline and follow-up questionnaires using weights defined as  $1 - [(I-j)/(k-1)]^2$ , where  $I$  = category for the first interview,  $j$  = category for the second interview,  $k$  = number of categories (Table 1).

## Results

The anthropometric and the physical activity characteristics of the participants were shown in Table 2. Anthropometric characteristics differed significantly between male and female but mean PAR was not significantly different. There was no significant sex difference in PAI and other activity-related parameters derived by the modified EPIC-PAQ. Table 3 shows the distribution of the participants into different occupational and recreational activities categories. Of all participants, 0% was categorized as inactive, 6.6% as moderately inactive, 16.2% as moderately active and 77.2% as active.

	Male (n=85)		Female (n=112)		Difference between sex p-value*
	Mean	SD	Mean	SD	
Age (y)	47.9	19.4	46.2	18.1	0.538
Weight (kg)	68.1	11.7	55.9	9.67	<0.001
Height (m)	1.68	0.071	1.57	0.061	<0.001
BMI (kg/m <sup>2</sup> )	24.1	3.5	22.8	3.8	0.02
% Body fat by BIA	22.7	6.0	30.8	7.1	<0.001
WC (cm)	89.0	9.5	81.6	8.7	<0.001
HC (cm)	98.7	6.2	96.6	6.63	.054
WHR	0.90	0.07	0.84	0.07	<0.001
Measured BMR (kcal/day)	1068	261	844	184	<0.001
Estimated TEE by HKPAQ (kcal/day)	3075	1078	2369	599	<0.001
PAR	2.9	0.8	2.9	0.8	0.628
Variables derived by EPIC-PAQ					
PAI (n, %)					
1 (inactive)	0	0%	0	0%	0.054**
2 (moderately inactive)	4	4.7%	9	8.0%	
3 (moderately active)	21	24.7%	11	9.8%	
4 (active)	60	70.6%	92	82.1%	
Vigorous exercise duration (h/week)	1.8	1.8	1.3	1.7	0.159
Stairs climbed (floors/day)	3.7	5.0	4.2	6.5	0.276

BMI – body mass index, BIA – bioelectrical impedance analysis, WC – waist circumference, HC – hip circumference, WHR- waist-hip ratio, BMR - basal metabolic rate, TEE – total energy expenditure, PAR – physical activity ratio, PAI – physical activity index, HKPAQ – Hong Kong Physical Activity Questionnaire, EPIC-PAQ – EPIC Physical Activity Questionnaire.

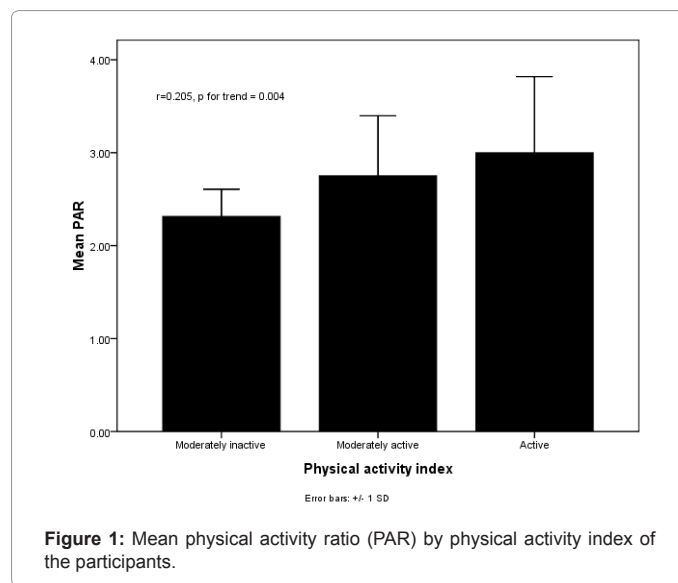
\* - independent two sample t-test for all parameters except chi square test for PAI\*\*

**Table 2:** Anthropometric and physical activity characteristics of the participants (n=197).

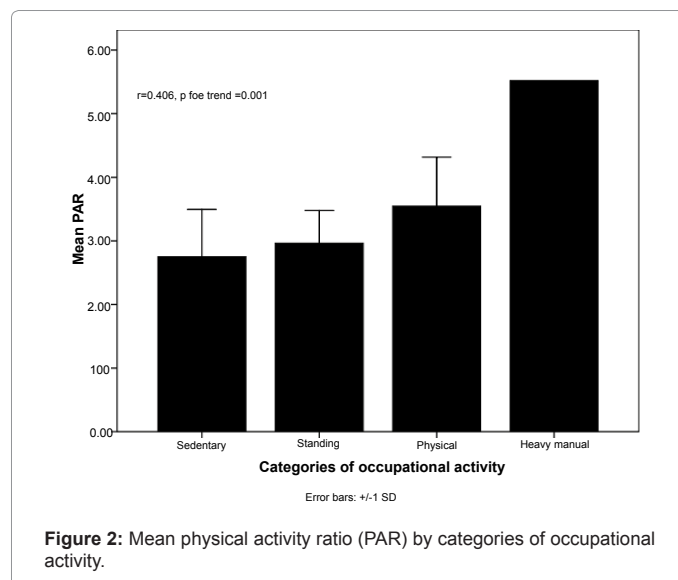
Recreational activities (h/week)	Occupational status			
	Sedentary	Standing	Physical	Heavy manual
0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
0-3.5	13 (6.6%) <sup>^</sup>	2 (1.0%) <sup>*</sup>	0 (0%)	0 (0%)
3.5-7	30 (15.2%) <sup>*</sup>	15 (7.6%) <sup>*</sup>	8 (4.1%) <sup>`</sup>	0 (0%)
>7	97 (49.2%) <sup>`</sup>	14 (7.1%) <sup>`</sup>	17 (8.6%) <sup>`</sup>	1 (0.5%) <sup>`</sup>

PA – physical activity, Activity was categorized into four levels intended to have public health meaning, i.e. none, up to 0.5 h/day, 0.5 to 1 h/d and more than 1 h/d. Symbols represent definition of PAI based on the distribution: <sup>^</sup> - moderately inactive, <sup>\*</sup> - moderately active, <sup>`</sup> - active.

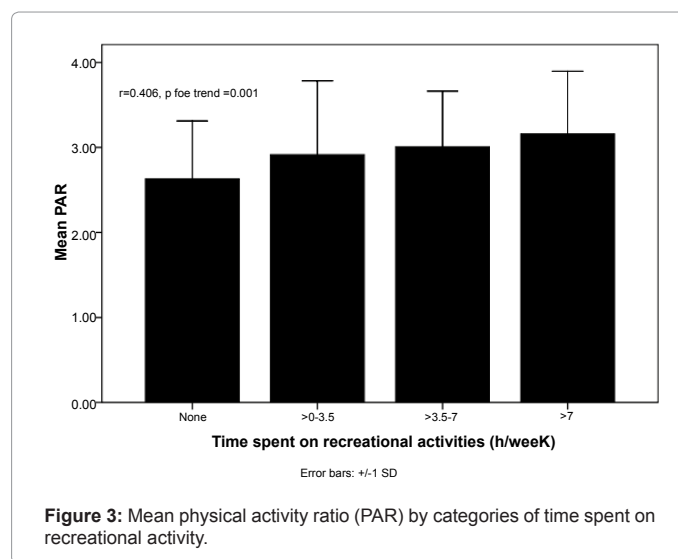
**Table 3:** Matrix illustrating the frequency distribution (%) of occupational status and reported participation in recreational activities from the modified EPIC-physical activity questionnaire of the participants (n=197).



**Figure 1:** Mean physical activity ratio (PAR) by physical activity index of the participants.



**Figure 2:** Mean physical activity ratio (PAR) by categories of occupational activity.



**Figure 3:** Mean physical activity ratio (PAR) by categories of time spent on recreational activity.

Baseline PAI	Follow-up PAI				Total
	Inactive	Moderately Inactive	Moderately Active	Active	
Inactive	0	0	0	0	0
Moderately Inactive	0	9	1	1	11
Moderately Active	0	6	26	9	41
Active	0	0	13	110	123
Total	0	15	40	120	175

Weighted kappa = 0.7,  $p < 0.0001$

**Table 4:** Reproducibility of the physical activity index (PAI) derived by the EPIC-physical activity questionnaire (n=175).

	PHS (2005)	THS (2007)	Present study	p value
n	5,683,000	5,700,000	197	---
Age range (y)	15 to >90	15 to >65	19 to 83	---
Average walking time (h/day)	1.3	N/A	1.8	<0.001 <sup>a</sup>
% of participants with walking time >1 h/day	45.5%	N/A	67.5%	<0.001 <sup>b</sup>
% of participants performed vigorous physical activities	9.2%	N/A	58.9%	<0.001 <sup>b</sup>
% of participants regularly undertaking physical activities	22.2%	37.2%	75.4%	<0.001 <sup>b</sup>
Weekly physical activities duration (h)	N/A	19.8	28.6	<0.001 <sup>a</sup>

N/A – Not available; a - independent t-test; b – chi-square test

**Table 5:** Comparison of physical activity patterns in Population Health Survey (PHS 2005) (Department of Health, 2005), Thematic Household Survey (THS 2007) (Census and Statistics Department, 2007) and the present study.

The PAR was significantly correlated with the PAI. There was a significant trend between the PAR and the PAI (Figure 1;  $r_s = 0.205$ ,  $p$  for trend = 0.004). The PAR was also significantly correlated with the categories of occupational activity and time spent on recreational activity components in the EPIC-PAQ (Figures 2,3).

Table 4 shows the results of the reproducibility of the PAI. The weighted kappa statistic for the comparison of the PAI at baseline with that for the repeat survey was 0.7 ( $p < 0.0001$ ).

## Discussion

This is the first study, to our knowledge, for the EPIC-PAQ to be examined in a Hong Kong Chinese population. In this study, the PAI derived by the EPIC-PAQ was compared with the PAR calculated as a ratio of total energy expenditure derived by the HKPAQ to the measured BMR.

We found that the PAR calculated was closely associated with the simple four-level occupational component (Figure 2) but only modestly associated with the time spent on recreational activity (Figure 3), a finding similar to the validation study by Wareham et al. [8]. This was also evidence to show that occupational activity was a stronger determinant of energy expenditure [9].

There was a significant association between the PAI derived from the EPIC-PAQ and the PAR estimated from the HKPAQ and BMR measurement (Figure 1), suggesting that participants with higher physical activity level with higher PAR could be classified into more active PAI categories. However, none of the participants in the present study was categorized under the inactive group. This finding

is different from those reported in the EPIC study. In the EPIC study, 30.7% participants were categorized as inactive. The discrepancy may be explained by differences in the living environment and the modes of transport between Hong Kong and Western countries. Most people in Hong Kong travel by means of public transport instead of private car, and they have to walk to get access to public transport. So, they walk a lot each day and it became the predominant recreation activity for the majority of Hong Kong people. Previous findings showed that walking solely contributed 41.2% of total physical activity time in the local population. As a result, none participants was categorized in the “Inactive” group.

Our study has limitations and strengths. Participants in the present study were volunteers and might be more aware of their health and may lead a more healthy lifestyle. They may be more active and might not be the representative of the general population. Compared with other studies reporting the physical activity levels of the Hong Kong population (Table 5) (Census & Statistics Department, 2007; Department of Health, 2005), our participants walked more and participated more in physical activities, especially in vigorous exercises. The lack of very inactive participants in this study could be viewed as a major limitation. We included participants at a broader age range (19-83 y) of both sexes, not limiting to the middle-aged and elderly population as originally designed, to increase the practical use of the modified EPIC-PAQ.

In conclusion, the EPIC-PAQ adapted for the local lifestyle was highly reproducible. Together with the significant trend of the PAI derived by this questionnaire with the PAR observed in the present study suggests that the EPIC-PAQ may be a reasonable tool to use in large epidemiological studies to rank Hong Kong Chinese population according to their physical activity level. Further validation of the EPIC questionnaire with other objective and sophisticated measurement of total energy expenditure is needed to confirm its applicability.

## Competing Interests

No competing interests.

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