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Development and Validation of the Physical Activity Questionnaire for Thai Children

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Abstract

Physical activity questionnaire (PAQ) for school children has not yet been established and validated in Thai children. This study aimed to develop a valid and reliable PAQ, and to establish the norms of physical activity level (PAL). Thai children aged 9-12 years were recruited in school settings. Three phases were obtained. The first phase contained data from 1,122 mailed questionnaires for item selection analysis and then the PAQ was developed. The validated phase was done in 179 children who wore the Computer Science Application (CSA) accelerometer as a criterion reference method. The last phase was about setting the norms for PAL, Thai validated PAQ was used in the survey. All together 728 PAQ entries were obtained from surveyed samples using the multistage random sampling technique. Total physical activity (PA) score was calculated based on metabolic equivalent (METs). Regarding validation with criterion reference using CSA, data set was obtained from 68 items. Concurrent validity was shown between PAQ and CSA (Pearson r = 0.40, $p<0.001$). Discriminant validity indicated that PAQ could classify children who were physically active. The reliability of PAQ, presented by Cronbach's alpha coefficient, was 0.92 and intra-class correlation was 0.76 ($p<0.001$). Factor analysis showed the predictive value of total PA score 66.9% of the variance. Norms of total PA score were derived from METs per week between 25th percentile corresponding to 310 METs and 75th percentile corresponding to 580 METs. The PAQ showed a good internal consistency and the agreement between PAQ and CSA data showed an acceptable validity and reliability. Therefore, PAQ can be used as a tool to assess PAL of Thai children aged 9-12 years.

Keywords: physical activity, questionnaire, reliability, validity, Thai children

1. Introduction

Physical activity level (PAL) is the crucial component for health promotion. It is important for identifying energy expenditure. Physical inactivity is known to be a major risk factor for overweight and obesity in children (1). The consequences of obesity can lead to high blood pressure, high blood triglycerides and total cholesterol, diabetes, and coronary artery disease (2, 3). World Health Organization recommends that in general people should exercise at least 30 minutes of moderate physical activity (PA) every day. For children and youth at least 60 minutes of moderate to vigorous intensity physical activity daily is recommended. This guideline provides young people through good physical, mental and social health (4). The results of the latest survey on exercising behavior among populations 11 years and older from the National Statistics Office, Thailand, showed the rate of exercise that 70.4 % performed adequate PAL and met the recommendation (5). PAL of children can be accurately assessed using the accelerometer but this method may be troublesome because of high cost of equipment, time consuming, and low compliance in children (6-8). Several studies have been performed to assess PAL using physical activity questionnaires (PAQ). This is known as the simple and reliable tool to quantify physical activity level (6-7, 9-11). PAQ is commonly accepted as instruments for population-based studies (12). However, few studies of physical activity in children indicated relationship between PAQ and accelerometer (10-12). Generally, physical activity levels of children are assessed based on the intensity of various physical activities that can be calculated as metabolic equivalent (MET) value. MET is defined as oxygen uptake in ml/kg/min with one MET equals to the oxygen cost of sitting quietly, equivalent to 3.5 ml/kg/min (13). Only studies on the validity and reliability of the PAQ for adults have been available (14) but very few for school children, hence the objectives of this study were to develop and validate PAQ to assess the physical activity against the Computer Science Application (CSA) accelerometer and to set norms of physical activity level of Thai school children aged 9-12 years.

2. Materials and Methods

The procedure of developing the PAQ for Thai primary school children aged 9-12 years was divided into three phases; Phase I: The prototype mailed questionnaires was developed using formative research in school children to obtain PA checklist; Phase II: CSA data set was used as a criterion method; Phase III: The PAQ was further used in the multistage sampling survey of physical activity in different provinces of Thailand. The ethical approval was obtained from the Institutional Review Board (IRB), Mahidol University.

2.1 Subject and sample size

The formative research conducted in-depth interview in children aged 9-12 years to find out the questions to be addressed for PAQ

Phase I: Valid and reliable questionnaire were distributed to the selected schools by mail. These schools were randomly selected from an official list of Ministry of Education, Thailand. The data obtained by this method were to be used as a basis for information items to develop context. The sample size calculation indicated that at least 5 questionnaires were needed for each item (15). The totals of 1,122 complete PAQs were used in the analysis.

Phase II: CSA was used as a criterion method for PAQ validation, the adequacy of the sample size for this study was calculated based on the value of correlation coefficient between CSA and PAQ. The sample data set consisted of 179 children. To perform the criterion

validity of PAQ in phase two, the adequacy of the sample size is necessary for an acceptable level of test-retest reliability of this method. Therefore, the sample size for this study was calculated based on the value of correlation coefficient between CSA and PAQ (r = 0.30) (16), using Fisher's z-transform to normalize the distribution of Pearson's correlation coefficient value (17).

$$n = \left[\frac{(Z_{\alpha/2} + Z_{\beta}) + 3}{[F(Z_0) - F(Z_1)]} \right] = 113$$

Where; α = Probability of type I error = 0.05(2-sided) = 1.96

β = Probability of type II error = 0.1

$1 - \beta$ = Power = 0.90 , $Z_{0.1}$ = 1.282

F(Z) = Fisher's Z transformation = 0.5 ln [(1+ρ)/(1- ρ)]

under $H_0 : \rho = 0.30$, $F(Z_0) = 0.5 \times \ln[(1+0)/(1-0)] = 0$

under $H_1 : \rho = 0.30$, $F(Z_1) = 0.5 \times \ln[(1+0.30)/(1-0.30] = 0.31$

Phase III: A survey for setting the PAQ norms was administered in primary school children. Multi-stage random sampling was used to represent Thai children. Two provinces in each region were randomly selected from 4 regions (north, south, northeast and central). After that, district, municipal and non- municipal areas were sequentially random selected, and the schools were randomly selected from those areas. The schools in Bangkok were also selected based on locations inner and outer areas. All children were randomly selected by sex, age, and nutritional status stratification. Nutritional status of children was stratified using weight-for height z-score (WHZ), Thai national growth reference (18). Children were classified as overweight when WHZ > +1.5SD; normal weight when WHZ between -1.5SD and +1.5 SD; thin when WHZ < -1.5SD. The ratio for overweight: normal: thin was 2:6:2. The total number of questionnaires according to calculated sample size was 728. For the PAL norms to be represented of the Thai children aged 9-12 years, multi-stage random sampling technique was used in the third phase. The sample size for simple random sampling was calculated as (19)

$$n = \frac{Z_{\alpha}^2 \, P(1-P)}{d^2} = 303$$

where; Z_{α} = confidence level at 95% (standard value of 1.96)

P = estimated of children aged 11^+ years with no physical activity = 26.9% (5)

d = margin of error at 5% (standard value of 0.05)

Since this phase used multi-stage random sampling technique, the sample size should be multiplied by the design effect, which is generally assumed to be 2 for survey study (20). Thus, the estimated sample size was 606. The sample is further increased by 20% to account for contingencies such as non-response or recording error.

2.2 Methods

In the first phase, sixty children were in-depth interviewed in one school to obtain the habitual activity list. The International Physical Activity Questionnaire (IPAQ) (21) and Global Physical Activity Questionnaire (GPAQ) (22) were used as an additional guideline for design to develop self-administered PAQ. The PAQ was constructed with 138 checklist items and distributed by mail for testing of the applicability of the items. Using the compendium of physical actives by Ainsworth et al. (13), MET was calculated from total physical activity (PA) score. Item analysis was used for reliability test and factor analysis was used for construct validity test. After that, items of the PAQ were reduced to the remainder 98 items.

In the second phase, the PAQ was modified from the results in phase one to assess the frequency of physical activity. The estimate duration of time was not included in this PAQ because it was difficult to judge by the children. However, the PAQ components were household activity, play activity, exercise activity and sport activity. The frequency of the past week physical activity was coded as 4 categories: "0 = never"; "1 = 1-2 days (sometime)"; "2 = 3-5 days (often)" and "3 = 6-7 days (almost every day)". Children wore the CSA model 7164 (Computer Science Application, Florida, USA) for 7 days and more than 14 hours per day, excepted while bathing or water active such as swimming. The PAQ were scored to measure energy expenditure by frequency (time per week), duration (hour per time), and intensity (23). The limitation of duration to estimate in these children, therefore the total PA score (METs value per week) was calculated based on the Compendium of Physical Activity (13), which obtained from the intensity plus frequency of that activity. The 68 items were retained and used in the test-retest reliability administration within the 1-3 days. Then the PAQ was used construct validity by factor analysis and concurrent validity between CSA data (count per week) set by correlation.

In the third phase, the 68 items PAQ were administered in Thai children aged 9-12 years in selected provinces for construct validity. In this step, the factor analysis was performed and 52 items remained to be used for setting of the PAL norms. The total PA scores (METs value per week) obtained from children were found to be non-normally distributed and non-parametric statistics such as median, 25^{th}, and 75^{th} percentiles were used.

2.3 Statistical analysis

A principal component factor analysis by the varimax rotation on all items developed was performed for testing of the construct validity (24, 25). Kaiser-Meyer-Olkin (KMO), which measures the sampling adequacy, should be greater than 0.5 for a satisfactory factor analysis to proceed (24). The Communality (h^2), the proportion of variance that each item has in common with other items, which is indicated as the squared multiple correlation, should be greater than 0.5 for considering the remaining items. The number of factors was determined if the eigenvalues greater than 1, the factor loading of 0.4 was used as a criterion for selecting the PAQ items (24). Concurrent validity (24) was done using Pearson correlation coefficient (r) between total physical activity score and CSA data. Discriminant validity (24) was assessed by comparing means of 27% of low and high total PA score group with independent t-test. Item-total correlation between the scores of an individual item was performed to test whether any item was redundant and could be discarded. The correlation less than 0.3 were rejected (25-27). Internal consistency reliability was assessed by Cronbach's alpha coefficients (α) and the alpha of 0.70 or higher (25, 27) was required for the PAQ to be acceptable. Intraclass correlation coefficient (ICC), with the value higher than 0.7, was used for considering the test-retest reliability (26). Percentiles of total PA score were then constructed for setting the Thai norms. All the analyses were performed by using SPSS software, version 18.0 (SPSS Inc, Chicago, IL, USA).

3. Results and Discussion

3.1 Characteristic data

The anthropometric characteristics of the children aged 9-12 years were demonstrated in Table 1 by study phases. The mailed data set consisted of 1,122 PAQs from children; 574 boys and 548 girls. The CSA data set was obtained from of 179 children; 90 boys and 89 girls. The survey data set included the PAQs from

728 children; 366 boys and 362 girls. Mean and standard deviation of age in all data sets ranged from 10.9 ± 0.9 to 11.5 ± 0.9 years for both boys and girls. Weight for both genders ranged from 36.2 ± 10.0 to 42.0 ± 12.4 kg. Height and Weight for height *z*-scores were similar among all data sets but they were significant different between boys and girls ($p < 0.05$). Body mass index (BMI) of all data sets ranged from 17.8 ± 3.6 to 20.0 ± 4.5 for both genders.

Table 1. Characteristics in each data set of PAQ.

	Mailed data (n = 1,122)		**CSA data (n =179)**		**Surveyed data (n = 728)**	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Number (%)	574 (51.2)	548 (48.8)	90 (50.3)	89 (49.7)	366 (50.3)	362 (49.7)
Age (years)	11.3±1.0	11.2±1.0	11.5±0.9	11.4±0.8	10.9±1.0	10.9±0.9
Weight (kg)	36.9±11.9	37.1±10.8	42.0±12.4	39.6±12.7	36.6± 11.4	36.2±10.0
Height (cm)	141.0±10.0 [a]	143.1±9.9 [a]	144.0±8.4	144.4±7.8	140.2±9.0 [d]	141.7±8.4 [d]
Weight for height *z*-score	0.33±1.6 [b]	-0.06±1.4 [b]	0.92±1.7 [c]	0.17±1.9 [c]	0.39±1.6 [e]	0.02±1.3 [e]
BMI (kg/m^2)	18.2±4.1	17.8±3.7	20.0±4.5	18.8±5.0	18.3±4.1	17.8±3.6

[a b c d e] Significant mean difference compared with boys and girls at $p<0.05$

CSA = the Computer Science Application, accelerometer

3.2 Validity

In the first phase, construct validity for item reduction was performed using the principal components extraction method. Results from the mailed date set (98 items) showed that the KMO for all activities was 0.96, which indicated the sampling adequacy. The communality using the extracted factors ranged between 39% and 65% of preferences activity. The item factor loadings ranged from 0.38 to 0.77 for each physical activity and 0.31 to 0.73 for all activities. The initial factor analysis resulted in 21 factors with eigenvalues >1. These 21 factors accounted for 52.5% of the total explained variance (Table 2).

In the second phase, construct validity was conducted once again in CSA data set using the principal components analyses. KMO measure was 0.82 and communality ranged from 0.55 to 0.83. The eigenvalues indicated that 18 factors accounting for 66.9% of the explained variance. Factor loadings ranged from 0.33 to 0.83 for all activities (Table 2). Pearson correlation for concurrent validity test between CSA data and the total PA score for all activities was 0.40 ($p<0.001$) (Table 3). Discriminant validity was assessed in this study by comparing means of 27% of low and high total PA score group with independent t-test. Total PA score group were found to be significantly different ($p<0.001$) which showed that PAQ had a sufficient power to discriminate children with low PAL and high PAL.

In the third phase, PAQ was obtained from 52 items of physical activity. KMO measure was 0.91 and communality ranged from 0.31 to 0.77. The initial factor analysis resulted in 12 factors with eigenvalues >1. This accounted for 56.1% of the total explained variance. The range of factors with item loading was identified from 0.40 to 0.85 (Table 2).

Table 2. Construct validity and internal consistency reliability in each data set of PAQ.

Physical activity	n of item	Item-total correlation	Cronbach's alpha (α)	% of variance explained	KMO	Commu-nality (h^2)	Factor loading
Mailed data set							
Sedentary	13	0.27 - 0.46	0.76	45.2	0.83	0.34 - 0.58	0.41 - 0.73
Household	10	0.33 - 0.50	0.75	42.0	0.86	0.24 - 0.33	0.46 - 0.72
Play	27	0.31 - 0.58	0.88	47.0	0.95	0.36 - 0.65	0.38 - 0.76
Exercise	24	0.32 - 0.51	0.83	45.8	0.94	0.33 - 0.61	0.40 - 0.76
Sport	24	0.26 - 0.58	0.87	50.2	0.90	0.37 - 0.65	0.43 - 0.77
All activity	**98**	**0.30 - 0.56**	**0.95**	**52.5**	**0.96**	**0.39 - 0.65**	**0.31 - 0.73**
CSA data set							
Household	20	0.21 - 0.68	0.86	61.2	0.83	0.47 - 0.75	0.46 - 0.81
Play	12	0.25 - 0.65	0.84	46.5	0.87	0.25 - 0.61	0.50 - 0.76
Exercise	20	0.30 - 0.58	0.82	57.0	0.84	0.36 - 0.78	0.39 - 0.83
Sport	16	0.27 - 0.61	0.80	62.1	0.78	0.47 - 0.82	0.47 - 0.89
All activity	**68**	**0.23 - 0.58**	**0.92**	**66.9**	**0.82**	**0.55 - 0.83**	**0.33 - 0.83**
Surveyed data set							
Household	19	0.28 - 0.64	0.88	55.3	0.90	0.32 - 0.78	0.47 - 0.81
Play	9	0.36 - 0.50	0.74	34.0	0.85	0.24 - 0.38	0.49 - 0.66
Exercise	11	0.22 - 0.52	0.72	42.6	0.85	0.26 - 0.53	0.46 - 0.73
Sport	13	0.30 - 0.56	0.76	56.6	0.84	0.44 - 0.65	0.43 - 0.80
All activity	**52**	**0.24 - 0.56**	**0.90**	**56.1**	**0.91**	**0.31 - 0.77**	**0.40 - 0.85**

KMO = Kaiser-Meyer-Olkin

Table 3. Concurrent validity between CSA data set and PAQ.

	Total CSA (count per week)	
	Correlation (r)	**P-value**
Total PA score (METs value per week)	0.399	.001

CSA = the Computer Science Application, accelerometer

3.3 Reliability

In the phase one, the 98 items of the PAQ were reduced. The item to total correlation for total PA score of all activities ranged from 0.30 to 0.56, while the Cronbach's Alpha was 0.95 (Table 2). For phase two, the items was reduced into 68 which resulted in item to total correlation ranged from 0.23 to 0.58 and the Cronbach's Alpha was 0.92 (Table 2). The test–retest reliability within the 1-3 days, using ICC, was shown to be 0.76 (95% CI: 0.69, 0.82) (Table 4). In the last phase, the item to total correlation of the PAQ with 52 items ranged from 0.24 to 0.56 and the Cronbach's Alpha was 0.90 (Table 2).

Table 4. Test-retest reliability of PAQ in CSA data set.

Total PA score (METs value per week)	N	ICC	95% CI*	
			Lower	Upper
Total	168	0.758	0.685	0.815
Boys	82	0.741	0.625	0.825
Girls	86	0.778	0.678	0.849

* 95% CI = 95% Confidence Interval, ICC = Intraclass correlation coefficient

3.4 Norms setting

According to the PAL analysis in the last study, using total PA score, the norms were derived from METs value per week between 25th percentile corresponding to 310 METs value and 75th percentile corresponding to 580 METs value. The average score was 452 METs value for the Thai children aged 9-12 years (Table 5).

Table 5. Norms of Total PA score in PAQ.

Total PA score from PAQ (METs value per week)	
Mean	452
Standard deviation	201
25th percentile	310
Median	429
75th percentile	580
Obtained range	66 - 1244
Potential range	0 - 1688

3.5 Discussion

Physical activity questionnaire (PAQ) and accelerometers (CSA) are commonly used in the survey to assess PA in the community. In our study we developed PAQ using formative research to gain the habitual activity in order to get PAQ checklist. We then validated the PAQ with CSA. In our study PAQ showed good internal consistency reliability by Cronbach's alpha coefficients greater than 0.9, test and retest reliability showed the intraclass correlation coefficients greater than 0.7. The concurrent validity by correlation showed 0.4 which was generally acceptable consistent with the study by Mota et al. (28) and Janz et al. (29). The result obtained was similar to the results from a large scale study in Spanish adolescents by Martinez-Gomez et al. (11).

Like in other studies, in this field the constraints of the data collection usually found in the recall process of PA in children. They sometime could not accurately recall their activities. Though we tried our best to make the PA checklist, there was still subjective and the

children may not be able to accurately report. About the CSA, though the children wore CSA for the 3 days, some of them had low compliance with this wearing, as they seemed to forget. The researchers reminded them by telephone call.

PAQ was developed according to the protocol of standard tool development to be used in population based study (11, 12). The application of using PAQ in the epidemiology study is well established. The advantage of using PAQ is its simple and cost less in assessing PAL. We then constructed the norm for Thai children from PA score (METs value per week) using percentile 25th and 75th. This could be a guideline to assess the PA in the community and be applicable for Thai children aged 9-12 years.

Further study is needed to investigate the predictive validity (27, 30) for the PAQ of children in different settings to classify the PAL of individuals who are physically active or inactive.

4. Conclusion

This is the first study to show the validity and reliability of physical activity questionnaire to determine the physical activity level in Thai children aged 9-12 years. In addition, the norms of physical activity level using total PA score (METs value per week) are established in this study. Findings from this study can be applied in related studies to assess physical activity level in other population. Thus, it consequently contributes to the foundation necessary for developing the strategies to promote optimal physical fitness among Thai children.

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