ORIGINAL ARTICLE

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Thai diabetes prevention education program: development and validation of the Thai physical activity questionnaire for at-risk people

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Abstract

Aim This study aimed to develop and validate the Thai physical activity questionnaire (Thai-PAQ) for Thai people at risk for type 2 diabetes (T2D).

Subjects and methods After development and validation of the questionnaire, 95 people at risk for T2D were recruited. The Thai-PAQ was developed based on the International-PAQ. The Thai-PAQ was evaluated by three experts to ensure content validity. The at-risk people were interviewed using the Thai-PAQ for the previous 7 days' activities. Spearman's correlation was used to compare the accelerometer and Thai-PAQ for concurrent validity. Interclass correlation was used to evaluate the reliability of the Thai-PAQ separated by 3 days. Chi-square test was used to represent significant differences ($p < 0.05$) in the proportion of participants meeting the current physical activity guidelines.

Results The content validity of the Thai-PAQ was 0.91. The total physical activity from the Thai-PAQ (MET-min week^{-1}), which included the part-time occupation domain and excluded the part-time occupation domain, was significantly correlated with the total physical activity (counts week^{-1}) according to the ActiGraph accelerometer ($r = 0.57$ and 0.54, $p < 0.01$, respectively). The 3-day test-retest reliability of the total physical activity of the developed PAQ was 0.86 ($p < 0.05$) when including the part-time occupation domain and was 0.85 ($p < 0.05$) when excluding the part-time occupation domain.

Conclusions The study showed that that concurrent validity had high correlation compared with the ActiGraph accelerometer. Reliability was also acceptable as high reliability. The Thai-PAQ is considered useful for communities as well as a means to ultimately promote physical activity in communities.

Keywords Diabetes prevention program · Physical activity questionnaire · Obesity · Thailand

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Introduction

Physical activity has been shown to be a key component of wellness and contributes to the prevention, treatment and rehabilitation of several non-communicable diseases (NCDs) (Physical Activity Guidelines Advisory Committee 2008). Physical activity is part of energy expenditure; consequently, it is fundamental to the energy balance and weight control (WHO 2009). Overweight and obesity increase the chance of developing diabetes and other NCDs. Lack or inadequacy of physical activity is one of the causes of the rapidly increase in obesity and a leading cause of diabetes (Mayor 2007).

Thailand is in an economic development transition, which has led to improvements of the infrastructure, technology and

food supply. This progress has promoted over-nutrition and sedentary lifestyles, leading to an increase of the prevalence of overweight, obesity and diabetes in both rural and urban areas (Vongsvat 2002). Type 2 diabetes mellitus (T2D) affects the Thai population. The diabetes incidence increased from 33 to 91 to 587 cases per 100,000 population in 1985, 1994 and 2006, respectively (Wild et al. 2004). It was estimated that from 2000 to 2025 the prevalence of diabetes would increase in Thai adults aged 20 years and over from 1,017,000 to 1,923,000 cases, indicating the prevalence of diabetes in Thailand is rising over time (Aekplakorn et al. 2011).

Although age, gender, ethnicity and family history are non-modifiable risk factors of diabetes, other risk factors, such as overweight and obesity, can be improved with adequate physical activity (Shai et al. 2006). The Ministry of Public Health (MOPH) recommended that the Thai population should increase physical activity and exercise in the physical activity recommendation of 2008 [Physical Activity Guidelines for America, the Centers for Disease Control and Prevention and the American College of Sports Medicine guideline (CDC/ASDM)] (Centers for Disease Control and Prevention 2011). The recommendation for adequate physical activity is at least 150 min per week of moderate-intensity aerobic activity, 75 min per week of vigorous-intensity aerobic activity or an equivalent combination of moderate- and vigorous-intensity aerobic activity per week (Centers for Disease Control and Prevention 2011). Thus, efforts to increase physical activity for people in communities are needed and should be considered one of the modifiable risk factors in health promotion programs.

Physical activity measurement is an important factor for a successful intervention program. The appropriate methods to assess physical activity in a population-based study are crucial. To assess populations' activity levels, a subjective measurement, such as a self-reported questionnaire, is the most common measurement in health promotion intervention trials (Montoye 1996). A questionnaire is needed to ensure accurateness for those populations in their contexts (Montoye 1996).

To respond to the global need for comparable and valid measurements of physical activity within and between countries, the International Physical Activity Questionnaire (IPAQ) was developed and tested for surveillance of activities covering most daily situations related to health-enhancing physical activity across various life domains (International Physical Activity Questionnaire 2005). Several researchers reported that the reliability and validity of IPAQ were acceptable compared with reference tools, such as the pedometer, accelerometer and double-labeled water technique (Craig et al. 2003; Deng et al. 2008; Dinger et al. 2006; Ishikawa-Takata et al. 2008; Plasqui and Westerterp 2007). Hence, the current IPAQ is accepted for use as one of the extensively validated questionnaires in several countries.

However, subjective measurements have some limitations in terms of their validity and reliability (Plasqui and Westerterp 2007; Shephard 2003). ActiGraph is an accelerometer tool to assess physical activity that has been extensively evaluated for validity and reliability (Hendelman et al. 2000). It is designed to measure the frequency, intensity, duration and pattern of activity (Laporte et al. 1985). Hence, the objective of this study was to develop and validate the Thai-PAQ for Thai people at risk for diabetes. The criterion validity of total physical activity was estimated from the IPAQ using the ActiGraph accelerometer as a reference measurement.

Methodology

Study design

This study was approved by the Research Ethics Committee of the Ministry of Public Health, Thailand. The study was conducted in a semi-urban area in Chiang Mai province in Thailand. The Thai-PAQ was developed by modifications based on the long-form, self-administered, 7-day version of the IPAQ. A procedure to validate the Thai-PAQ for people at risk for diabetes was carried out. The IPAQ was evaluated for content validity by three experts comparing data on the level and pattern of physical activity obtained by the Thai-PAQ. The concurrent validity was obtained by ActiGraph motion sensor measurement. Reliability was also analyzed by the Thai-PAQ, which was produced for a different period.

Setting

The study was conducted in a semi-urban area in Chiang Mai Province where there is a cultivated area. Agriculture is the main occupation of the local people. They also work as traders, laborers and government staff. Moreover, there are many tourist locations in this area, which provides another source of income for the local people.

Sample

The sample size was calculated using a test of the significance of one correlation coefficient formula, calculated as follows:

Test of the significance of one correlation coefficient:

$$n = \left[\left(z_{\alpha/2} + z_{\beta} \right)/C \right]^2 + 3$$

where

C	$0.5 \ln \left[(1 + r)/(1 - r) \right]$
α	0.05 (two-sided), $\beta = 0.2$
n	84.7
n	84.7 + drop out 20%

Total participants = 102

All 115 participants were recruited from communities and were 30 to 69 years old. They were at risk for diabetes, but they were not yet diabetic patients based on the Thai screening criterion (Aekplakorn et al. 2006). The subjects were examined for screening risk factors for diabetes by community healthcare workers (CHCWs) in each community using the diabetes screening system. Ninety-five participants who met the inclusion criteria were willing to participate in the study (Fig. 1).
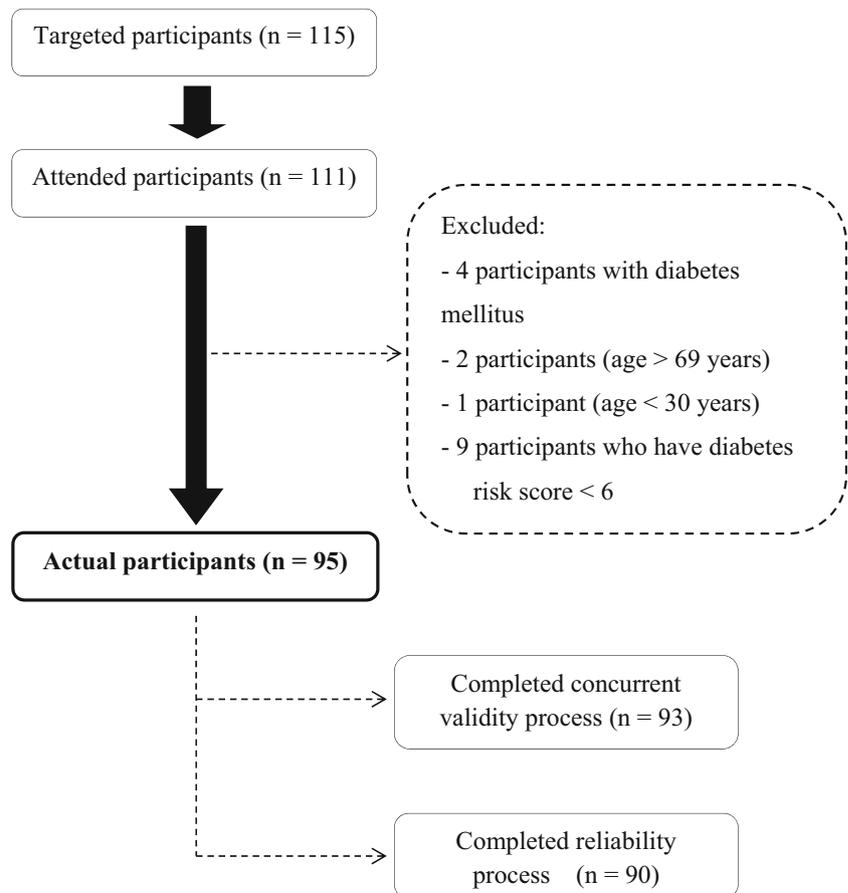
Development of the Thai-PAQ

The Thai-PAQ was developed by modifying the long, self-administered, 7-day version of the IPAQ and the formative evaluations, which were obtained by interviewing the CHCWs, health volunteers and people at risk for diabetes (Sranacharoenpong and Hanning 2011). The observation was carried out by healthcare centers and communities. The questionnaire determined how often participants had performed physical activity within the previous 7 days. The Thai-PAQ is composed of four physical activity domains and one sedentary behavior domain. The four domains were occupation, household, leisure-time activity and transportation. A sedentary behavior setting domain was also included.

The main occupational activity was related to the performance of a job, usually within the time frame of an 8-h work day (Howley 2001). There were three levels of main occupational activity: light, moderate and vigorous (Reis et al. 2005). Household activity was defined as all activities associated with maintaining both the inside and outside of a house, including moderate and vigorous (Ainsworth et al. 2000). Leisure-time physical activity was a broad indicator of the activities that subjects participated in during their free time, depending on their personal interests and needs (Ainsworth et al. 2000). Finally, sedentary behavior was associated with time spent watching TV or sitting or lying down to read newspapers or magazines. In each of the four physical activity domains, participants were asked to recall the frequency (day per week) and duration (time per day) of both moderate and vigorous physical activity. The sedentary behavior domain was recorded through a single question about the frequency and duration of activity. Lists of culturally relevant moderate and vigorous physical activity and sedentary behavior were given throughout.

The activity intensity of each item on the questionnaire was grouped based on Metabolic Equivalent of Task (MET) values in the published compendium table of physical activity (Ainsworth et al. 2000). In this study, moderate physical activity was defined as 3–6 METs and vigorous physical activity as > 6 METs (Garber et al. 2011). One MET is equal to energy expenditure at rest of 3.5 ml·kg^{-1}·min^{-1} or approximately

Fig. 1 Diagram of the study sampling framework

- Targeted participants (n = 115)
- Attended participants (n = 111)
- Excluded:
  - 4 participants with diabetes mellitus
  - 2 participants (age > 69 years)
  - 1 participant (age < 30 years)
  - 9 participants who have diabetes risk score < 6
- **Actual participants (n = 95)**
- Completed concurrent validity process (n = 93)
- Completed reliability process (n = 90)

1 kcal/kg/h (Manley 1996). Outcome measures used were: (1) MET-minutes per week and (2) length of time (minutes or hours) reported for moderate and vigorous physical activity per week. Results of the calculated "MET-minutes per week (MET-min week^{-1})" depending on the number of minutes spent on each activity class were multiplied by the specific score for that activity class based on the MET values and formula for the computation of MET-minutes guideline of the IPAQ (International Physical Activity Questionnaire 2005). According to the Centers for Disease Control and Prevention/American College of Sports Medicine guideline, total activity of each participant was used to classify participants into the "active" or "inactive" group (Diabetes Prevention Program Research Group 2002). Researchers adapted the Thai-PAQ to conform to the culture and competence of the participants. We used the face-to-face interview method instead of self-administration to gather physical activity data from participants. The method was suitable for participants who had a low education or literacy level.

Validity and reliability criteria

Content validity

The first draft of the Thai-PAQ was performed for content validity by instructions mailed to three experts. All experts were requested to identify the content relevance for the intended purpose of the instrument and conceptualization of the construct of interest for the development stage. Meanwhile, all experts also evaluated the relevance and adequacy of items for representing the hypothetical content in the correct proportions for the judgment stage.

The data from three experts were used to analyze for content validity. The item-level content validity index (I-CVI) was selected to compute for each item of the scale, and the average of the I-CVI values across items (S-CVI/average) was used to represent the overall scale. Inappropriate and obscure items were reappraised and refined according to the comments and suggestions of the experts.

Concurrent validity

As subjective measurements have many limitations in terms of their validity, objective or direct measurements of physical activity are generally used to increase accuracy and precision and to validate the subjective measurements (Shephard 2003). Therefore, concurrent validity was needed to estimate the capability of the final draft of the Thai-PAQ to distinguish among people who differed in their present status according to some criteria.

The uniaxial accelerometer [Computer Science Applications (CSA), Inc., AcitiGraph model 7164 accelerometer (Shalimar, FL)] was selected for this study. This is an unobtrusive and easy-to-use device. It is $5.08 \times 4.06 \times 1.52$ cm, lightweight (42 g) and powered by a lithium battery that lasts approximately 6 months. The digitized acceleration signals are filtered and digitized by a microprocessor to a numerical value, which discriminates human movement from vibrations. Data from the accelerometer are automatically revealed as counts, which measure the frequency and intensity of vertical accelerations and decelerations. Physical activity counts are aggregated and stored at the end of each user-specified time interval (epoch). The AcitiGraph was initialized to set to zero before each assessment session started as described in the manufacturer's instruction. The Excel macro from the Windows-based ActiGraph Co. software was used to integrate the physical activity counts into 60-s epochs, and then the integrated values were reported in units of count/min and continued to accumulate in the memory. The physical activity counts and time spent in habitual activities were derived from the prediction equation of Freedson and Miller's study (2000). Physical activities were determined as time spent in moderate [1952–5724 counts (3–6 METs)] and vigorous [≥ 5724 counts (≥ 6 METs)] exercise. All activities were defined as having light, moderate and vigorous physical activity intensity levels in each period of time, developing a compendium of physical activities (Ainsworth et al. 2000). The AcitiGraph model 7164 accelerometer requires calibration prior to data collection by one experimenter wearing ten accelerometers around the waist at the same time and then running on a treadmill for 30 min, increasing the speed levels every 10 min. The accepted data from each ActiGraph must be calibrated to ± 10% of the mean value of the standard (Ainsworth et al. 2000).

Twenty accelerometers, CSA model 7164, were used. Participants were given a booklet on how to use the accelerometer and the date to return the machine. Accelerometers were attached to each participant's right waist over the right hip bone during their waking hours (at least 10 h per day), except when bathing or participating in water activities, for 7 consecutive days (5 weekdays and 2 weekends). Participants had to record the time they woke up, slept and took off the accelerometer for more than 1 h. Throughout these 7 days, participants were contacted by phone to remind them to wear the accelerometer. If the participants did not wear the accelerometer for 7 consecutive days (5 weekdays and 2 weekends) or a minimum of 5 days (4 weekdays and 1 weekend), they were asked to wear the accelerometer for additional time. If they did not wear the device long enough, they were excluded from this study.

Reliability

After participants completed their monitoring period, the accelerometers were removed and given back, and the participants were interviewed about their daily activities using the Thai-PAQ on two separate occasions. Participants were interviewed to complete the Thai-PAQ by recalling the

physical activities carried out during the previous 7 days. After 3 days, they were interviewed to redo the Thai-PAQ for reliability testing.

Data collection

The data collection was conducted in a private room at the healthcare center of each community. Participants were instructed on how to use the accelerometer and how to fill in the booklet. The accelerometer was attached to each participant for 7 consecutive days, and the starting time was recorded. On day 4, the participants were contacted via phone call to remind them to wear the accelerometer. On day 8, the last day for concurrent validity testing, the participants returned to the healthcare center to take off the accelerometer and completed the first Thai-PAQ. Data on anthropometric and demographic characteristics were also collected. On day 11, the participants returned to the healthcare center and completed the second Thai-PAQ for reliability testing. The estimated physical activity levels of each participant and suggestions were returned in the booklet.

Data analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences for Windows, version 21.0. The characteristics of participants were described by percentage. The Wilcoxon Mann-Whitney test was used to determine significant differences between groups according to the test's objectives. Non-parametric Spearman's correlation coefficients were used to test the strength of the relationship between the total physical activity determined by the Thai-PAQ (MET-min week^{-1}) and activity counts (counts week^{-1}) from the ActiGraph accelerometer. Test-retest reliability of the Thai-PAQ was used for evaluation by interclass correlation coefficients (ICCs) from the second time the Thai-PAQ was performed, which was separated by 3 days. Cohen's guideline (Suzuki et al. 1998) was used to classify the correlations, i.e., $r < 0.30$ (small); $r = 0.31$–0.50 (moderate); $r > 0.50$ (high). Chi-square test was used to represent the significant differences of the proportions of participants meeting the current physical activity guidelines. The level of significance was set at alpha = 0.05.

Results

Characteristics of the participants

Characteristics of the participants are shown in Table 1. The 95 participants lived in six communities in the Mae On district. Approximately 70% of participants were female. The average age was 46.8 years (SD = 7.3), ranging from 30 to 69 years. Educational levels of participants were 58% primary and 33% secondary school. Occupations of participants

Table 1 Characteristics of participants ($N = 95$)

Characteristics	n (% of sample)
Gender	
Male	29 (30.5)
Female	66 (69.5)
Age (years)	
30–39	17 (17.9)
40–49	39 (41.1)
50–59	34 (35.8)
60–69	5 (5.3)
Mean ± SD	46.8 ± 7.3
Education	
Master's degree	3 (3.2)
Bachelor's degree	2 (2.1)
Secondary education	31 (32.6)
Primary education	55 (57.9)
None	4 (4.2)
Occupation	
Government employee	5 (5.3)
Office worker	13 (13.7)
Trader	25 (26.3)
Agriculture worker	16 (16.8)
Laborer	16 (16.8)
Other	11 (11.6)
None	9 (9.5)
BMI	
Mean ± SD	27.2 ± 4.2
Waist circumference	
Male (≥ 90 cm)	8 (8.4)
Female (≥ 80 cm)	53 (55.8)
Hypertension	38 (40.0)
Family history of type 2 diabetes	51 (53.7)
Diabetes risk score	
Median (min, max)	9 (6, 16)
Mean ± SD	9.4 ± 2.5

mostly involved trade (26.3%), agriculture (16.8%) and labor (16.8%). The average body mass index (BMI) was 27.2 kg/m^2 (SD = 4.2). The average the diabetes risk score was 9.4 (SD = 2.5) with a maximum score of 16, and half of the participants had a family history of type 2 diabetes.

Psychometric property assessment

Content validity

The content validity of the Thai-PAQ was evaluated by a panel of three experts. The result of the content validity index (CVI) was 0.91. The experts also suggested comments for items of the Thai-PAQ revised version.

Concurrent validity and reliability

Some participants had both full- and part-time occupations. Hence, the part-time occupation domain was included in the Thai-PAQ to assess physical activity. However, only a few participants had part-time work in their daily life. Table 2 presents the concurrent validity and reliability results of the Thai-PAQ. The total physical activity on the Thai-PAQ (MET-min week^{-1}), which included the part-time occupation domain and excluded the part-time occupation domain, was significantly correlated with the total physical activity (counts week^{-1}) according to the ActiGraph accelerometer ($r = 0.57$ and 0.54, $p < 0.01$, respectively), while the 3-day test-retest reliability for the total physical activity from the developed PAQ was 0.86 ($p < 0.05$) including the part-time occupation domain and was 0.85 ($p < 0.05$) excluding the part-time occupation domain.

Table 3 shows that the total physical activity values of people at risk for diabetes according to the Thai-PAQ between including and excluding part-time occupations were not different. Hence, these results confirmed that the question related to part-time occupations on the Thai-PAQ should be excluded from use at the community level.

Proportion of participants meeting physical activity guidelines

Comparing the Thai-PAQ and the ActiGraph accelerometer data (CDC/ASDM) [9], the proportion of participants who were measured as active by the developed PAQ (62.1%) was higher than that measured by the ActiGraph accelerometer (47.3%). In contrast, the proportion of participants who were inactive as measured by the developed PAQ (37.9%) was lower than that measured by the ActiGraph accelerometer (52.7%). However, there was no difference in the proportion of participants measured as active and inactive by both instruments (Table 4).

Discussions

This study examined the validation and reliability of the Thai-PAQ for people at risk for diabetes aged 30–69 years who live in a semi-urban area. The findings provided evidence of the validity and reliability of this measure, which were acceptable for assessing physical activity in participants at risk for diabetes at the community level.

The current study of the Thai-PAQ was developed by modification based on the long, self-administered, last 7-day version of the IPAQ and the formative results. According to the guideline for data processing and analysis of the IPAQ (2005), the Thai-PAQ is composed of four domains of physical activity and one domain of the sedentary behavior setting. The review in 2010 reported that all physical activity domains, such as occupational activity, household activity, leisure-time activity, transportation, and sports, were covered by the questionnaire for the purpose of measuring total physical activity (van Poppel et al. 2010). These patterns were similar to those of other studies that aimed to measure total physical activity (Berthouze et al. 1993; Boon et al. 2010; Pols et al. 1997; Singh and Purohit 2011; Suzuki et al. 1998). This evidence suggested that the new tool, the Thai-PAQ, was able to capture all the main components and estimate the total amount of physical activity. In addition, completeness of the information acquired using the qualitative approach was an important strategy to ensure that the activities of each item within the Thai-PAQ were relevant to the lifestyle behaviors (van Poppel et al. 2010). Hence, to develop and validate the Thai-PAQ, formative results were necessary for compiling specific physical activity information according to lifestyle behaviors and community backgrounds.

The number of days required for data collection to represent habitual physical activity has been an issue for researchers. This questionnaire was designed to use the participants' recollection of their typical activities in the past 7 days (short time frame). According to Welk's study (2002), the most appropriate number of days to measure typical activities was the past 7 days, which covered all activities of both the weekdays and weekend.

In this study, the researchers got acquainted with the participants before obtaining the information. This is a crucial step to make participants feel at ease with the researchers. They were also able to talk without shame or trying to please the researchers. To help them understand the questions, the researchers asked the questions with clarification face to face. Bauman's study used face-to-face IPAQ interviews to evaluate total physical activity in adults aged between 18 and 65 years in six countries (Bauman et al. 2009). In Thailand, Visuthipanich's study (2008) developed and validated the self-reported PAQ for older aged participants by using face-to-face interviews to

Table 2 Validation and reliability separated between the Thai-PAQ including part-time occupation and excluding part-time occupation

Thai-PAQ (MET-min week^{-1})	Number of items	CSA validation r value	Test-retest reliability R value
Including part-time occupation	11	0.57**	0.86*
Excluding part-time occupation	8	0.54**	0.85*

r Spearman correlation coefficient; *R* interclass correlation coefficient; *Thai-PAQ* Thai Physical Activity Questionnaire, *CSA* Computer Science Applications, Inc., AcitiGraph accelerometer

**$p < 0.01$; *$p < 0.05$

Table 3 Total physical activity from the Thai-PAQ including part-time occupation and excluding part-time occupation

Thai-PAQ	Included part-time occupation	Excluded part-time occupation	P value
MET-min week^{-1} (mean ± SD)	13,310.8 ± 11,168.7	12,484.3 ± 10,944.9	NS

Thai-PAQ Thai Physical activity questionnaire

evaluate total physical activity. These studies were consistent with Sallis's study (2010), which confirmed the importance of good interviewers to obtain the correct responses.

The concurrent validity of this study was evaluated by comparing data on the total physical activity obtained by the Thai-PAQ (MET-min week^{-1}) and the motion sensor measurement (ActiGraph Accelerometer) (count week^{-1}). The two data sets were determined as the interval level and the non-normal distribution. Therefore, Spearman's correlation coefficient was selected to investigate the concurrent validity of this study. The concurrent validity was 0.57. However, the total physical activity of people at risk for diabetes according to the Thai-PAQ, which excluded part-time occupations, was 0.54. To confirm that both correlations were not different, the Wilcoxon Mann-Whitney test was used to analyze the difference in total physical activity from the Thai-PAQ between including part-time and excluding part-time occupations. The results showed that the part-time occupational domain did not influence the correlation of the total physical activity from the Thai-PAQ and ActiGraph accelerometer. Hence, to use the Thai-PAQ at the population level, a lower participant burden, elimination of participants' confusion, ease of administration and time limitations of the assessment should be considered (Sallis 2010; Welk 2002). These results and evidence confirmed that the Thai-PAQ's questions related to part-time occupations should be excluded. This will be more practical for use at the community level.

The level of correlation was moderate. However, according to Cohen's guideline (1988), this correlation is well accepted for behavioral research. This finding was consistent with other validity studies of PAQ development in other countries. For example, the study of Miller et al. (1994) reported that the correlation was 0.45 compared with the Caltrac accelerometer in healthy adults in the USA. Another study from New Zealand reported that the correlation coefficient between total physical activity from the New Zealand Physical Activity Questionnaire (NZPAQ-LF) and

ActiGraph accelerometer was 0.3 (Boon et al. 2010). Furthermore, this study also compared NZPAQ-LF with IPAQ (long form version), and a small correlation (0.30) was reported. The IPAQ conducted across 12 countries by Craig reported criterion validity correlations for the last 7 days with the uniaxial accelerometer model 7164 (Craig et al. 2003). The results showed that the criterion validity correlations ranged from 0.14 to 0.53, with a median of approximately 0.30 (Miller et al. 1994).

Pongurgsorn's study (2002) used self-administered developed T-PAQ with 24 items to assess physical activity over the past 7 days. The participants were adults aged between 26 and 50 years who lived in Bangkok. The T-PAQ was evaluated for validity by comparison with an accelerometer and showed a small correlation of 0.30. Wattanasit's study (2010) developed the questionnaire for children aged 12–18 years. The questionnaire assessed how often participants had been physically activity within the past 7 days. The questionnaire was validated by comparison with an accelerometer worn for 7 days, and the correlation coefficient was 0.26.

The results of this study showed that the 3-day test-retest reliability of the Thai-PAQ was 0.86, including the part-time occupation domain. It was not different from the Thai-PAQ, which excluded the part-time occupation domain ($R = 0.85$). The reliability assessment of the Thai-PAQ can be problematic because of its difficulty in differentiating instrument reliability from true variation in physical activity behavior. The time interval and recalled period for reliability evaluation varied among studies (Miller et al. 1994). This study examined a 3-day time interval for test-retest reliability for separate occasions. According to Fiona, the recommended optimal period to assess reliability was between 3 and 7 days (Armstrong and Bull 2006). For time repeated data at fewer than 3 days, the participants' memory can be the obstruction affecting the reliability of correlation coefficients. In contrast, if time repeated data are collected at more than 7 days, the participants may be unable to provide accurate recall of their physical activity levels (Armstrong and Bull 2006). Another possibility is that participants may be careless when using the same instrument if they are familiar with the process in the second administration (Armstrong and Bull 2006). The results were produced haphazardly with the effect of a spuriously low estimate of reliability (Armstrong and Bull 2006).

Table 4 Proportion of participants meeting the CDC/ASDM guideline cutoffs as measured by the Thai-PAQ and ActiGraph accelerometer

Guideline	PAQ	CSA	Chi-square test
Active	59 (62.1)	44 (47.3)	NS
Inactive	36 (37.9)	49 (52.7)	
Total	95 (100)	93 (100)	

Thai-PAQ Thai Physical activity questionnaire, *CSA* Computer Science Applications, Inc., AcitiGraph accelerometer, *CDC/ASDM guideline* The Centers for Disease Control and Prevention/American College of Sports Medicine guideline

Conclusion

The results of tool development and validation showed that the Thai-PAQ for people at risk for diabetes at the community level

was modified based on the long, self-administered, last 7 days version of the IPAQ and behavior of Thai people based on formative results. The concurrent validity showed high correlation compared with the ActiGraph accelerometer. Reliability was also acceptable as high reliability. Ultimately, the Thai-PAQ will be considered useful as a community-based intervention program to prevent diabetes.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Ethical consideration of this study was sent for approval by the Chiang Mai Public Health Office Institutional Review Board, Ministry of Public Health, Thailand. All the respondents signed an informed consent form.

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