

The Reliability and Concurrent Validity of a Modified Version of the International Physical Activity Questionnaire for Adolescents (IPAQ-A) in Tunisian Overweight and Obese Youths

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Key Words

International Physical Activity Questionnaire for Adolescents · Reliability · Validity · Overweight · Obese · Pedometer

Abstract

Objective: The aim of the present study was to assess the reliability and validity of an Arabic version of the International Physical Activity Questionnaire for Adolescents (IPAQ-A) modified for use in Tunisia among overweight and obese adolescents. **Subjects and Methods:** Fifty-one voluntary healthy, overweight or obese adolescents (15–18 years old) participated in the study. Physical activity (PA) indicators derived from the modified self-administered IPAQ-A were compared with pedometer-recorded data of step counts. The test-retest reliability of the IPAQ-A was evaluated using intraclass correlation coefficients (ICC) and Kappa tests between the response of participants in the two interviews. Validity was assessed using Spearman's rank correlation coefficient between the scores of the IPAQ-A and the step count pedometer. **Results:** ICC revealed that the reliability of IPAQ-A values was high and ranged from 0.73 to 0.95. IPAQ-A

scores were also significantly related to pedometer step counts ($r = 0.66$, $p < 0.001$). Strong relationships were observed between pedometer step count data and the IPAQ-A data for vigorous PA ($r = 0.57$, $p < 0.001$) and walking ($r = 0.61$, $p < 0.001$). However, a weaker relationship for moderate PA was observed ($r = 0.24$, $p < 0.05$). **Conclusions:** The modified version of the IPAQ-A questionnaire demonstrated an acceptable reliability and validity when used to assess the levels and patterns of PA in overweight or obese Tunisian adolescents.

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Introduction

Physical activity (PA) during adolescence is positively related to health in adulthood [1] and is inversely related to being overweight and to the associated metabolic and cardiovascular risks [2, 3]. A valid PA instrument is necessary for understanding the association between an active lifestyle and health [3, 4]. PA can be measured by a variety of objective and subjective methods; hence, it is necessary to have standardized, reliable and valid instru-

ments that can be used in many countries [5]. The International Physical Activity Questionnaire (IPAQ) was developed to enable the measurement of all dimensions of health-enhancing PA in the population group aged 15–65 years in different cultural milieus [6]. The IPAQ is available in short (IPAQ-S) and long (IPAQ-L) versions. The IPAQ was carefully adapted for adolescents and has been modified to measure PA during school periods, hereafter referred to as the IPAQ for Adolescents (IPAQ-A) [3, 4]. It has been shown that the IPAQ-A has reasonable validity properties for assessing activities in different intensities and for total PA in healthy European adolescents aged 15–17 years [3]. Previous research also indicated that the reliability and validity of the PA questionnaire for older children and adolescents varied by race [3, 7, 8], and that more research is needed to further investigate and improve the quality of the IPAQ-A [3, 4]. However, until now, research on instruments for assessing PA in Arabic countries has been very scarce [9] and an Arabic version of the IPAQ-A has not been validated.

The dose-response relationship between PA and health outcomes in overweight Tunisian adolescents is unclear. Therefore, accurate measurement of PA for these overweight adolescents particularly using an adapted validated PA questionnaire remains a challenge.

The pedometer has become one of the most popular tools for measuring PA because of its low cost and easy use. Equally important is that it has been used as a convergent measure of validity in previous reports and showed a fair validity and high reliability [10–12].

Therefore, the aim of this study was to translate and adapt an existing English version of the IPAQ-A into Arabic, and to test the reliability and the concurrent validity of the adapted and modified version of the IPAQ-A against an electronic pedometer among a group of overweight and obese Tunisian adolescents.

Subjects and Methods

Study Sample

Our population was selected among 400 overweight and obese pupils from the Majida Boulila secondary school in Sfax city (located in the south-east of Tunisia). This sample was recruited from a school-based cross-sectional study conducted by the Unit of Obesity and Metabolic Syndrome, Department of Endocrinology, Hedi Chaker Hospital Sfax, and was designed to examine the prevalence of metabolic syndrome among overweight and obese adolescents and its association with PA [2]. The school where the study was implemented was selected because it is the largest in Sfax and due to the willingness of the students to cooperate with their physical education teachers, who had received training on the use of a

pedometer. The present study was approved by the Ministry of Education and the Ethics Committee of Hedi Chaker Hospital, Sfax, Tunisia. This study was conducted throughout the school year 2012–2013.

Students were informed about the study aims. All participants and their parents provided written informed consent; participants did not receive any incentives and could withdraw from the study at any time. Inclusion criteria were students between the ages of 15 and 18 years, with a body mass index (BMI) above or equal to the value that predicts overweight or obesity by applying the age- and sex-specific International Obesity Task Force (IOTF) BMI cut-off points [12], and no orthopedic disease or injury that could limit PA. A total of 100 overweight and obese adolescents were randomly selected to participate in the study according to weight status, age and sex. Due to the limited number of pedometers available, a subsample of the study population, 60 adolescents aged 15–18 years, were randomly selected to wear the instruments. Complete data were obtained from 51 pupils (28 girls and 23 boys). The exclusion criteria were severe sickness during the study period or failure to complete all parts of the study (questionnaire or measures missing).

All measurements were conducted in the school clinic and performed by the school nurse. Anthropometric standardization exercises were conducted to ensure uniform techniques. All subjects underwent a thorough physical examination, including anthropometric and blood pressure assessments.

Weight was measured without shoes or heavy clothes using a Tanita electronic scale (Tanita BF 571, Tanita Corporation, Tokyo, Japan) and was recorded to the nearest 100 g. Standing height was measured with a suspended Microtoise tape to the nearest 0.1 cm. BMI was calculated as the weight in kilograms divided by the square of height in meters (kg/m^2). The subjects were classified as overweight/obese based on the age and sex IOTF BMI cut-off points. Waist circumference (WC) was measured in centimeters with a nonelastic tape at a point midway between the lower border of the rib cage and the iliac crest at the end a normal expiration.

PA Assessment

Prior to the study, the modified version of the IPAQ-A (HELENA study version) [3] was translated from English to Arabic following the instructions given in the IPAQ manual [6]. The interviews with adolescents led to the identification of adaptations. The key times spent doing PA in a habitual week were during physical education classes (PA during breaks was not considered), traveling, housework and leisure time [3]. As in the HELENA study, the household domain was shortened to include only one question (compared to three in the IPAQ) about physical activities in the garden or at home, such as carrying loads, washing windows, scrubbing floors or sweeping [3]. The numbers of days per week and time periods per day spent walking, in moderate PA (IPAQ-A MPA) and in vigorous PA (IPAQ-A VPA) were recorded.

The different elements of the IPAQ-A questionnaire are shown in table 1. A total measure of PA (IPAQ-A TOT) was obtained by summing all values for each dimension of PA. For calculation of the total PA, the data were transformed into energy expenditure estimated as the total metabolic equivalent (MET) using published values and recommendations from the IPAQ scoring protocol [6]. One MET was the resting metabolic rate during quiet sitting, equal to 3.5 ml of oxygen consumption per kilogram per minute. To calculate the daily PA (MET minutes per day), the number of minutes

Table 1. Descriptive values (median and 95% CI) of pedometer and IPAQ-A anthropometric and PA measures in the study group

	Total (n = 51)		Girls (n = 28)		Boys (n = 23)		p value
	median	95% CI	median	95% CI	median	95% CI	
Age, years	17.00	16.61–17	17	16.39–17	17.00	16.63–17.15	0.29
Weight, kg	89.00	85.52–94.76	82	78.96–90	90.5	87.88–101.69	0.04
Height, cm	170.00	1.66–171.58	168.0	163.87–169.95	171.00	167.59–174.62	0.09
BMI	30.7	30.26–32.26	29.60	28.76–31.68	31.0	30.75–33.49	0.05
WC, cm	93.00	91.77–98.68	90.00	86.85–95.06	94.50	93.58–103.70	0.04
Pedometer steps/day	8,820	8,498.17–9,168.79	8,750.00	7,665.94–9,262.27	1,0150.00	8,949.54–11,046.98	0.04
IPAQ-A VPA, min/day	10	9.10–12.66	9.00	7.85–9.79	11.00	9.73–17.05	0.01
IPAQ-A MPA, min/day	20	18.39–23.49	17.00	15.76–25.98	21.00	18.59–23.41	0.20
IPAQ-A walking, min/day	71	66.45–74.22	68.00	63.09–72.63	74.00	66.78–79.91	0.07
IPAQ-A TOT, min/day	103.00	95.37–108.37	97.92	91.25–104.39	106.00	94.45–119.20	0.28
IPAQ-A TOT (MET), min/week	2,761	2,598.46–3,026.17	2,669.50	2,454.30–2,850.42	2,914.00	2,591.90–3,422.18	0.14

reported in each activity level was multiplied by its specific MET score. We used the IPAQ recommendation of MET estimates: VPA = 8 METs, MPA = 4 METs and walking = 3.3 METs [6, 13]. The IPAQ-A outcome variables used in the study were walking (min/day), IPAQ-A VPA (min/day), IPAQ-A MPA (min/day), the estimate of PA in total minutes per day IPAQ-A TOT (min/day) and the total METs per week (IPAQ-A TOT; MET/week).

Reliability and Validity

The reliability of the IPAQ-A was evaluated by asking each adolescent to complete the questionnaire one week after first taking it, using a test-retest design. For validity, an objective measurement of PA was assessed using an electronic pedometer (SW-200, Yamax DigiWalker, Tokyo, Japan). Previous research had shown the Yamax pedometer to be a valid and reliable assessment tool for measuring steps, distance walked and walking behavior [10, 14, 15]. Each participant completed an individualized 20-step pedometer calibration to assess the functional status of each pedometer. Participants were instructed to place the pedometer on the right side of the body attached to either a belt or waistband on the anterior midline of the thigh. Pedometers were worn during all waking hours, except when bathing or swimming, and removed prior to going to sleep at night. The inclusion criterion was a pedometer recording of at least 10 h per day for 7 days, of which 1 had to be a weekend day [15].

Study Conduct

On day 1, each subject was enrolled by the school nurse and the study procedures were explained to him/her, and measures of chronologic age, weight, height and WC in a standardized manner were taken. On the same day, each participant received a personal demonstration of the placement and use of the pedometer by trained professionals (physical education schoolteachers).

The adolescents then wore the pedometer for 7 consecutive days. On day 8, the adolescents returned to the school nursing room and completed the IPAQ-A form during a face-to-face interview with their physical education teachers. The subject was asked to recall their recent activity during the last 7 days. One week

after the first completion, each subject was asked to respond to the questionnaire again.

Statistical Analysis

All statistical analyses were performed using the software Statistical Product and Service Solutions (version 15.0 SPSS Inc., Chicago, Ill., USA). As the data were not normally distributed, they were presented as median values. The data were analyzed both for the whole group and by gender. The difference between genders was tested using a nonparametric Mann-Whitney test. To evaluate reliability, both Kappa tests and intraclass correlation coefficients (ICC) were used. Classification agreement between the tests and retests was examined using Kappa tests based on groups defined by IPAQ VPA, IPAQ MPA and IPAQ-A walking.

Nonparametric Spearman's correlation coefficients were calculated to assess the relationship between pedometer step counts and the time spent walking, IPAQ-A MPA, IPAQ-A VPA and the IPAQ-A TOT (MET/week) data. A p value <0.05 was considered to be statistically significant.

Results

The mean age of the 51 subjects was 16.8 ± 0.69 years (range 25.1–40.6). Thirty-two adolescents were obese and 19 were overweight. Descriptive characteristics of the population sample are shown in table 1. Males were heavier (90.5 vs. 82 kg, $p < 0.05$) and had a greater WC (94.5 vs. 90 cm, $p < 0.05$) compared to females.

The median and 95% CI values of IPAQ-A VPA, MPA and TOT walking were 10 (9.1–12.06), 20 (18.39–23.49) and 71 (66.45–74.22) min/day, and for TOT MET were 2,761 (2,581–3,026.17) min/week. Furthermore, based on the questionnaire, the only significant gender difference was in IPAQ-A VPA. Boys spent significantly more time

Table 2. Test-retest reliability of the IPAQ-A questionnaire (ICC and Kappa tests) in the study group

	ICC	95% CI	% agreement	K	p value
IPAQ-A VPA, min/week	0.95	0.94–0.96	58.8	0.49	<0.001
IPAQ-A MPA, min/week	0.73	0.55–0.82	52.5	0.40	<0.001
IPAQ-A walking, min/week	0.82	0.65–0.91	54.9	0.44	<0.001

than girls engaging on vigorous physical activities (11.00 vs. 9.00 min/day, $p < 0.01$). The steps counted per day were significantly higher in boys than girls (10,150 vs. 8,750 steps/day, $p < 0.05$).

Reliability

The reliability (ICC) of the IPAQ-A for all the adolescents ranged from 0.73 to 0.95. The overall reliability of the IPAQ-A questionnaire varied for the different PA levels. The lowest correlation was for IPAQ-A MPA (min/week), while the highest was for IPAQ-A VPA (min/week; table 2). In fact, the classification properties of the repeated questionnaires showed significant results with classification agreement: 58.8% ($K = 0.49$; $p < 0.001$) in VPA, 52.5% ($K = 0.40$; $p < 0.001$) in MPA and 54.9% ($K = 0.44$; $p < 0.001$) in walking.

Criterion Validity

The relationships between pedometer step counts and the time spent walking, and moderate and vigorous physical activities are presented in table 3. Pedometer step counts were strongly correlated with time spent doing vigorous activity ($r = 0.57$, $p < 0.001$), walking ($r = 0.61$, $p < 0.001$) and in IPAQ-A TOT (MET min/week; $r = 0.66$, $p < 0.001$) compared to moderately intense activity ($r = 0.24$, $p = 0.01$).

Discussion

In this study, IPAQ-A was a reliable and valid method for assessing habitual PA among Tunisian adolescents. The results showed good reliability with high correlations between the test and retest of the IPAQ-A, reinforcing those of previous studies [16, 17]. The reliability of the MPA questions in this study was a little less than of VPA and walking. The good reliability in our study could be due to the fact that the questionnaire was administered by physical education teachers using a face-to-face interviewing method. Also, our result may be due to the high prevalence of subjects whose vigorous physical activities are limited to the physical education session. Moreover,

Table 3. Validity (Spearman's correlation) of the IPAQ-A modified with pedometer recordings (steps/day)

	Boys	Girls	Total
IPAQ-A VPA, min/day	0.53***	0.56***	0.57***
IPAQ-A MPA, min/day	0.23*	0.30**	0.24*
IPAQ-A walking, min/day	0.60***	0.61***	0.61***
IPAQ-A TOT (MET), min/week	0.66***	0.65***	0.66***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

the majority of their walking time was spent on the path to school, which is easier to recall. Our finding concurred with other studies for adolescents by showing that there were no or only minor gender differences [18]. The reliability of the IPAQ questionnaire has also been confirmed in Chinese [19] and Brazilian [20, 21] populations.

In other adolescent studies the reliability of IPQA ranged from good to fair (in Norway $r = 0.10$ – 0.55 [3] and in Vietnam $r = 0.33$ – 0.52 [4]). Nevertheless, interindividual variation in the understanding of the concepts under investigation here is likely to exist. Older children likely have a better recall ability than younger children [4]. In this context, Kurtze et al. [16] noted that adolescents aged between 16 and 18 years had a higher reliability correlation than the younger adolescents.

In the present study, the IPAQ-A showed acceptable validity, giving a significant and positive correlation between the IPAQ-A score and the pedometer step counts. Different approaches have been applied in the validation of PA questionnaires, including accelerometer, pedometer, recall-logs, heart-rate monitoring and different energy expenditure methods [14]. In our study we used the pedometer, which has been extensively used in previous reports and was found to be valid for measuring steps and to be accurate in lean, overweight and obese subjects [10, 11].

Our findings are consistent with other studies reporting that boys perform more vigorously intense PA than girls [22–24]. The data based on international studies in-

dicates that among children we can expect boys to average 12,000–16,000 steps/day and girls to average 10,000–13,000 steps/day [22]. A study based on overweight adolescent girls showed that 10,000–11,700 steps/day may be associated with 60 min of moderate or vigorous PA [23].

The findings of the present study showed a positive relationship between pedometer step counts and the IPAQ-A data. This was confirmed in a previous study [25] where a positive relationship was observed between the pedometer step counts and the IPAQ data for total PA and VPA, but a weaker relationship was shown for MPA. Also, Gauthier et al. [26] proved that total activity scores (IPAQ) were significantly related to pedometer step counts. Allor and Pivarnik [27] found that PA recall was highly valid among 46 sixth-grade girls when compared with accelerometer recordings. Among Saudi Arabian adolescents a similar, significant correlation was found between the PA questionnaire (Arab Teens Lifestyle Study) and the pedometer step counts [9].

In the present study, the correlation between pedometer step counts and the IPAQ-A was high for the time spent walking and on VPA compared to MPA. This correlation is in agreement with previous studies [3, 4, 9]. In fact, Hagstromer et al. [3] reported that the self-reported time spent on MPA was higher compared to that measured with the accelerometer, while the differences between either measure were less clear for VPA. Previous research has also indicated that high-intensity physical activities are more structured and stable over time and are easier to recall [28, 29]. However, there was an overestimation of time spent on moderate activities [3, 4, 12]. The high correlation with walking may be related to the fact that a pedometer is built to accurately capture and record the steps of walking and not all types of PA .

In the present study, the pedometer measurements were performed for the same time period as of the questionnaire. Thus, there is no reason to believe that the respondents did not refer to their physical activities in or outside school in the same week when answering the questionnaire as that measured by the pedometer. For our study, we think that the involvement of the physical education teachers in the conduct of this study, in particular in the measurement of daily PA (by questionnaire and step count pedometer), increased the motivation of the pupils to engage in the study. Generally, schools are considered the best place to conduct health surveys or studies among adolescents [30].

Although it has many advantages, the assessment of PA by the questionnaire method suffers from several limitations. These limitations include the social desirability

effect of the questionnaire and the recall bias. In addition, the questionnaires tested are not designed to give a detailed insight into the types of activity reported or important determinants that could affect the study results, such as perceptions of the concepts studied and motivation. Respondents may sometimes have difficulty understanding obscure terms such as physical activity or moderate intensity, etc. [11].

Also, one limitation of this study is that a single estimate of the energy costs of a specific activity is applied to all adolescents. This does not allow for interindividual variation in energy expenditure for a given intensity or for variations in mechanical and metabolic efficiency between overweight or obese and nonoverweight subjects.

We have validated the IPAQ-A questionnaire against electronic pedometer measurements. Although the pedometer is a reliable instrument and provides an objective estimate of the level of PA, it is not the best standard criterion for assessing habitual PA [9, 11]. Furthermore, a pedometer cannot record the intensity of PA.

In the present study, we collected step counts for overweight and obese adolescents aged 15–18 years. It would have been much better if our population was composed of adolescents with varying BMI values as well as ages.

Conclusion

The findings of the present study provided support for the validity of the modified Arabic version of the IPAQ-A as an instrument for the assessment of habitual PA among Tunisian adolescents. Additional efforts should be made to develop specific instruments to assess PA in overweight and obese youths in Arab countries.

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Disclosure Statement

The authors report no conflicts of interest in relation to this work.

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