Send Orders for Reprints to reprints@benthamscience.ae

The Open Sports Sciences Journal , 2017, *10*, (Suppl-2, M4) 239-250

The Open Sports Sciences Journal

Content list available at: www.benthamopen.com/TOSSJ/

DOI: 10.2174/1875399X01710010239

RESEARCH ARTICLE

Validation of the Portuguese Version of the International Physical Activity Questionnaire for Adolescents (IPAQA)

Vera Ferro-Lebres[1,2], Gustavo Silva[1], Pedro Moreira[1,3] and José Carlos Ribeiro[1,*]

[1]*CIAFEL – Research Center in Physical Activity, Health and Leisure, Faculty of Sports, University of Porto, Rua Dr. Plácido Costa, 91, 4200-450 Porto, Portugal*

[2]*Diagnostic and Therapeutic Technologies Department, School of Health Sciences, - Polytechnic Institute of Braganza, Avenida D. Afonso V, 5300-121 Bragança, Portugal*

[3]*Faculty of Nutrition and Food Sciences, University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal*

Received: August 11, 2017 Revised: November 29, 2017 Accepted: December 4, 2017

Abstract:

Background:

Questionnaires have been broadly used to assess physical activity in adolescents, however validation studies, although essential, are not always performed.

Objective:

The present work aims to determine the validity of the Portuguese version of the International Physical Activity Questionnaire for Adolescents against 3 axis Actigraph accelerometers.

Method:

A cross-sectional study was conducted, with a sample of 222 adolescents, with a mean age of 15.6 years (SD=2.05). After translation and cross cultural adaptation, data obtained from the questionnaire was correlated to accelerometers data, using Spearman correlation coefficient. Percentages of agreement of physical activity tertiles obtained by each method were tested using Cohen's Kappa. Statistical analysis was performed for the total sample, per sex and per age group.

Results:

A significant correlation between the questionnaire and accelerometer was found for older adolescent boys, for total physical activity (ρ=0.372; P<0.01), and for moderate to vigorous physical activity (ρ=0.428; P<0.01) No correlations were found for the younger adolescents and girls. A 42.3% agreement was found for the questionnaire and accelerometer tertiles of total physical activity.

Conclusion:

The concurrent validity proved that the questionnaire might be valid only for older adolescent boys. The authors consider that whenever available physical activity objective measurements should be used instead of questionnaires.

Keywords: Adolescent, Motor Activity, Questionnaires, (IPAQA), Cohen's kappa, Accelerometer.

1. INTRODUCTION

Regular physical activity has been widely mentioned as contributing to several health benefits in all age ranges, namely for mental health [1], bone health [2], diabetes [3], cardiovascular disease [4] and obesity [5].

* Address correspondence to this author at the Research Centre in Physical Activity, Health and Leisure, Faculty of Sport, University of Porto, Rua Dr. Plácido Costa, 91, 4200-450 Porto, Portugal, Tel:+351220425292, E-mail: jribeiro@fade.up.pt

Physical activity (PA) assessment is therefore essential in surveillance, screening, programme evaluation and intervention studies. In order to obtain valid and reliable measures of PA, objective and improved methods of evaluation are recommended [6, 7], such as those from accelerometers, although they have a high cost and frequently are unavailable. In children and adolescents the difficulties of use have been referred [8 - 10]. And considering the recommended protocols, particularly in larger sample studies, questionnaires have been used as an alternative [11 - 13].

The International Physical Activity Questionnaire (IPAQ) is the more widely used and accepted questionnaire; it has proven to be valid and reliable for adults, in several countries and in different formats: long version, short version, self-reported and telephone interview [14].

Researchers detected the need to validate a PA questionnaire for adolescents, because the type and duration of activities are unique for this age group [15], either for intensity, frequency, type and location of practice. Schools, commuting and organized physical activity have major importance for this age group. Also the adolescents' reasons for being physically active differ from those of children and adults and elderly. For adolescents body shape, weight management, new social networks and support from family and peers are significant motivations. Even so, adolescents' PA is more similar to that of adults than of children [15]. Hence, adaptations and validations of IPAQ for Adolescents (IPAQA) have been published in some countries [16 - 19]. Although a validation of IPAQ for Portuguese adults has been done [20], the Adolescents version, IPAQA, is not yet validated for Portuguese adolescents.

The present work aims to determine the validity of the Portuguese version of the IPAQA using GT3X+ Actigraph accelerometers.

2. METHODS

2.1. Study Sample

A convenience sample of 222 high school students (123 girls), from two different schools in the north of Portugal, completed the questionnaire. Schools were included based on their willingness to participate, and on socioeconomic similarity; the 222 students included were the ones present at classrooms on the days of data collection and when the accelerometers were distributed. Participants had a mean age of 15.6 years (SD=2.05) and body mass index (BMI) age centile classification revealed 31.2% of adolescents with overweight/ obesity. Tables (**1** and **2**) summarize sample characteristics, per age group.

2.2. Ethical Approval

This study was conducted according to the guidelines defined in the Declaration of Helsinki and all procedures involving human participants were approved by the Research Centre in Physical Activity, Health and Leisure Scientific Committee. Written informed consent was obtained from all the parents or legal guardians.

The involved schools' directors gave their ethical approval. Adolescents were given the opportunity to refuse participation.

2.3. Data Collection

Data were collected between 2011 and 2013.

In the first visit to each classroom, anthropometric assessment was performed and accelerometers were distributed.

Height was measured using a SECA 217 portable stadiometer, with a 0.1 cm precision. Weight was assessed with 100g precision, using TANITA BC-545 body composition analyser. This equipment was also used to determine body fat percentage. BMI was calculated and categorized according to Centers for Disease Control and Prevention 2000 [21]. The minimum perimeter between the iliac crest and the rib cage corresponded to the waist circumference and the maximum protuberance of the buttocks corresponded to the hip circumference. A non-elastic tape was used to measure circumferences. For all anthropometric assessments adolescents wore light clothes.

The adolescents used the Actigraph GT3X+ accelerometers during 7 consecutive days, according to previously suggested protocols [7]. Students and parents received written information on how to use the accelerometer, before giving written consent. On the eighth day the accelerometers were collected and students completed IPAQA.

The first author and/or the responsible teacher from each class supervised the self-administration of IPAQA in small groups, in a classroom environment.

IPAQA analysis was performed according to original version guidelines [16]. Minutes at each intensity were limited to a maximum of 180 minutes per day, and a minimum of 10 minutes per activity was assumed, whenever adolescents indicated having engaged in that activity in the past week.

2.4. Translation and Cross Cultural Adaptation of the IPAQA

Three individuals proficient in English with a pedagogical background independently translated the IPAQA into Portuguese. The individuals are the first author and two high school English teachers. The authors compared the three translated versions and combined them into one collaborative-pooled Portuguese version.

A backward translation (Portuguese to English) was prepared by a native English speaker who was unaware of the original version and not familiar with PA subject area.

The backward translation was compared to the original questionnaire and all the authors approved the Portuguese version.

The original version remained unchanged during the translation process. The Portuguese version of IPAQA maintained the four original domains of PA [7]: (1) School related Physical Activity; (2) Transportation; (3) Housework; and (4) Leisure time.

Table 1. Descriptive data and Mann-Whitney U comparison of anthropometric characteristics and physical activity obtained by accelerometer and IPAQA, for adolescents aged 14 years or under.

		≤14y								Boys *vs.* Girls	
		Girls (n=33)				Boys (n=42)				Mann-Whitney U	
		Mean ± SD	Median	IQR (P25-P75)	IQR	Mean ± SD	Median	IQR (P25-P75)	IQR	Z	P-Value
	Age (years)	13.1±0.6	13.0	(13.0-14.0)	1.0	13.2±0.6	13.0	(13.0-14.0)	1.0	-.291	.771
	Height (cm)	156.9±6.0	157.0	(152.0-162.0)	10.0	158.4±7.8	158.7	(152.8-164.0)	11.3	-.887	.375
	Weight (kg)	53.2±9.4	53.0	(48.4-58.1)	9.8	52.6±12.3	50.7	(46.0-58.0)	12.0	-.806	.420
	BMI ($kg.m^{-2}$)	21.5±3.0	21.5	(19.6-23.2)	3.6	20.9±4.2	20.6	(18.1-22.3)	4.2	-1.473	.141
	BMI Centile	72.2±22.5	79.3	(62.3-89.1)	27.8	65.2±27.8	75.3	(45.0-86.3)	41.3	-.934	.350
	Body Fat (%)	30.6±6.7	28.4	(26.1-33.9)	7.8	23.1±7.8	20.8	(17.4-26.2)	8.9	-4.606	**.000**
	Waist Circumference (cm)	71.6±7.8	69.2	(67.0-76.2)	9.2	71.6±12.8	68.0	(66.4-74.1)	7.7	-1.267	.205
	Hip Circumference (cm)	89.3±7.1	89.0	(86.0-93.5)	7.5	86.1±10.0	82.5	(80.0-89.3)	9.3	-2.720	.007
Accelerometer	Total Measured Time ($min.day^{-1}$)	850.9±64.1	876.6	(788.6-905.6)	117.0	812.8±72.2	827.6	(776.6-868.1)	91.5	-2.177	**.029**
	Sedentary PA ($min.day^{-1}$)	509.4±85.7	514.3	(454.9-567.8)	112.9	446.4±104.0	420.2	(371.1-510.2)	139.0	-3.213	**.001**
	Light PA ($min.day^{-1}$)	295.3±64.1	276.0	(253.4-343.1)	89.7	315.5±61.8	313.7	(264.4-366.1)	101.7	-1.291	.197
	Moderate PA ($min.day^{-1}$)	36.0±15.1	31.3	(26.2-49.3)	23.0	55.1±17.7	54.3	(41.7-67.4)	25.6	-4.376	**.000**
	Vigorous PA ($min.day^{-1}$)	10.2±11.2	4.8	(2.5-17.3)	14.8	15.7±10.7	11.8	(7.2-24.3)	17.1	-3.047	**.002**
	MVPA ($min.day^{-1}$)	46.2±22.9	41.9	(31.1-66.8)	35.6	70.8±24.8	65.3	(49.8-86.6)	36.8	-4.093	**.000**
	Total PA ($counts.min^{-1}$)	427.3±132.6	404.2	(350.2-494.2)	144.0	584.6±145.1	590.8	(460.9-709.6)	248.7	-4.344	**.000**
	Total PA ($steps.day^{-1}$)	14875.1±5136.9	15495.8	(10141.6-19160.3)	9018.7	16953.4±5582.1	18220.8	(12284.2-20918.1)	8633.9	-1.569	.117

(Table 1) contd.....

		≤14y								Boys *vs.* Girls	
		Girls (n=33)				Boys (n=42)				Mann-Whitney U	
		Mean ± SD	Median	IQR (P25-P75)	IQR	Mean ± SD	Median	IQR (P25-P75)	IQR	Z	P-Value
IPAQA	Total Reported Time (min.day^{-1})	150.0±120.7	98.6	(77.7-208.6)	130.9	160.6±109.8	139.3	(62.7-230.4)	167.7	-.576	.564
	Motor Transportation (min.day^{-1})	19.6±20.0	19.0	(0.0-30.0)	30.0	29.4±41.9	7.1	(0.0-51.4)	51.4	-.016	.987
	Walking (min.day^{-1})	60.0±47.3	51.4	(25.4-75.0)	49.6	54.2±52.5	45.2	(8.2-90.4)	82.1	-.823	.411
	Moderate PA (min.day^{-1})	48.4±55.4	30.0	(7.1-64.3)	57.1	52.7±52.4	37.6	(10.7-83.6)	72.9	-.427	.669
	Vigorous PA (min.day^{-1})	41.6±40.9	25.7	(12.9-64.6)	51.8	53.6±43.6	36.4	(19.8-77.8)	58.0	-1.580	.114
	MVPA (min.day^{-1})	90.0±87.7	52.6	(31.4-121.8)	90.4	106.3±77.4	87.4	(39.6-167.1)	127.5	-1.185	.236
	Total PA (MET.min.day^{-1})	778.9±661.5	498.2	(313.9-1033.2)	719.3	881.6±593.7	730.6	(356.6-1282.1)	925.5	-.966	.334

Abbreviations: SD, standard deviation; IQR, Interquartile range; BMI: Body Mass Index, PA: Physical Activity; IPAQA: International Physical Activity Questionnaire for Adolescents; MVPA: Moderate to Vigorous Physical Activity; MET: Metabolic Equivalents.

Table 2. Descriptive data and Mann-Whitney U comparison of anthropometric characteristics and physical activity obtained by accelerometer and IPAQA, for adolescents aged 15 years or over.

		≥15y								Boys *vs.* Girls	
		Girls (n=90)				Boys (n=57)				Mann-Whitney U	
		Mean ± SD	Median	IQR (P25-P75)	IQR	Mean ± SD	Median	IQR (P25-P75)	IQR	Z	P-Value
	Age (years)	17.0±1.2	17.0	(16.0-18.0)	2.0	16.7±1.2	17.0	(16.0-18.0)	2.0	-1.032	.302
	Height (cm)	161.8±6.9	162.0	(158.0-165.0)	7.0	171.8±7.5	171.0	(168.0-177.0)	9.0	-7.012	**.000**
	Weight Kg)	60.4±11.4	59.3	(53.8-64.1)	10.3	65.4±10.2	66.0	(56.8-72.0)	15.2	-3.313	**.001**
	BMI (kg.m^{-2})	23.0±3.5	22.5	(21.2-24.6)	3.4	22.1±2.7	22.0	(20.0-23.6)	3.6	-1.618	.106
	BMI Centile	62.7±24.4	67.5	(50.9-80.4).	29.55	57.2±25.6	56.9	(41.0-81.4)	40.4	-1.344	.179
	Body Fat (%)	28.4±6.3	27.6	(24.7-31.2)	6.6	18.3±4.4	17.4	(15.2-20.0)	4.8	-8.312	**.000**
	Waist Circumference (cm)	74.1±8.9	72.0	(69.0-77.0)	8.0	75.1±7.3	73.0	(70.5-77.5)	7.0	-1.614	.107
	Hip Circumference (cm)	96.8±8.3	95.3	(91.0-100.0)	9.0	93.4±6.0	92.0	(89.0-97.0)	8.0	-2.557	**.011**
Accelerometer	Total Measured Time (min.day^{-1})	784.7±76.7	788.6	(738.0-844.9)	106.9	821.7±85.7	842.6	(777.4-876.1)	98.7	-2.984	**.003**
	Sedentary PA (min.day^{-1})	519.6±112.2	510.3	(453.8-563.0)	109.2	530.1±137.4	504.5	(450.8-578.0)	127.2	-.119	.905
	Light PA (min.day^{-1})	254.8±68.0	245.7	(205.0-302.5)	97.5	275.8±78.0	263.6	(229.9-316.3)	86.4	-1.545	.122
	Moderate PA (min.day^{-1})	23.8±11.8	22.1	(16.7-27.6)	10.9	37.5±19.3	36.6	(22.1-47.6)	25.4	-4.632	**.000**
	Vigorous PA (min.day^{-1})	9.1±9.8	6.7	(1.9-12.6)	10.7	18.3±14.1	15.4	(8.3-24.2)	16.0	-4.876	**.000**
	MVPA (min.day^{-1})	32.9±18.7	29.4	(19.5-41.1)	21.6	55.8±29.2	52.4	(30.3-72.6)	42.4	-4.940	**.000**
	Total PA (counts.min^{-1})	354.9±130.9	343.1	(268.1-412.6)	144.5	474.8±169.1	441.5	(352.4-592.9)	240.5	-4.560	**.000**
	Total PA (steps.day^{-1})	8116.8±3534.3	7280.9	(5822.1-9584.7)	3762.6	11494.9±6216.3	10122.8	(6800.2-13930.3)	7130.1	-3.526	**.000**

(Table 2) contd.....

		≥15y								Boys *vs*. Girls	
		Girls (n=90)				Boys (n=57)				Mann-Whitney U	
		Mean ± SD	Median	IQR (P25-P75)	IQR	Mean ± SD	Median	IQR (P25-P75)	IQR	Z	P-Value
IPAQA	Total Reported Time (min.day^{-1})	133.2±111.7	99.3	(47.5-197.9)	150.4	122.8±86.2	101.4	(63.6-185.4)	121.8	-.014	.989
	Motor Transportation (min.day^{-1})	34.3±36.6	25.7	(5.7-42.9)	37.1	36.0±41.5	22.9	(6.4-50.0)	43.6	-.307	.759
	Walking (min.day^{-1})	71.6±60.5	60.0	(21.4-108.2)	86.8	51.4±46.9	35.7	(15.4-76.4)	61.1	-1.757	.079
	Moderate PA (min.day^{-1})	40.1±49.3	20.0	(8.6-60.0)	51.4	34.9±39.2	21.4	(5.7-44.3)	38.6	-.058	.954
	Vigorous PA (min.day^{-1})	21.5±24.5	17.1	(4.3-25.7)	21.4	36.4±35.5	30.0	(10.7-53.6)	42.9	-2.796	**.005**
	MVPA (min.day^{-1})	61.6±66.7	32.9	(20.0-88.8)	68.8	71.3±59.9	51.4	(27.1-104.3)	77.1	-1.641	.101
	Total PA (MET.min.day^{-1})	133.2±111.7	99.3	(47.5-197.9)	150.4	122.8±86.2	101.4	(63.6-185.4)	121.8	-.014	.989

Abbreviations: SD, standard deviation; IQR, Interquartile range; BMI: Body Mass Index, PA: Physical Activity; IPAQA: International Physical Activity Questionnaire for Adolescents; MVPA: Moderate to Vigorous Physical Activity; MET: Metabolic Equivalents.

2.5. Concurrent Validity

Concurrent validity is a form of criterion validity, that uses a correlation with a criterion, ideally a gold standard, that is administered simultaneously [22]. In this study, the accelerometers were used as criterion and the IPAQA completed regarding the same time period.

The Actigraph GT3X+ considers acceleration in 3 axes: vertical, medio-lateral and antero-posterior. This device measures and records time varying accelerations ranging in magnitude from +/- 6*g,* which are subsequently digitized by a 12-bit analogue-to-digital converter at a rate between 30 and 100 Hz. The raw data are stored for subsequent analysis.

The accelerometer was used with an elastic belt in the waistline, positioned in the anterior axillary line of the non-dominant side. The device was initialized, selecting the 3-second epoch. Adolescents received both verbal and written information on how to use the accelerometer, based on previous researches [7]; instructions on use were given during 7 consecutive days, starting immediately after waking up and until going to bed, except for water activities (bath and swimming).

After usage, accelerometer data were processed using Actilife (version 6.9, Actigraph, Florida). The data was reduced to one-minute periods (epochs) and wear and non-wear time was determined according to previous recommendations [23]. Time periods with at least 90 consecutive minutes of zero counts recorded were excluded from analysis assuming that the monitor was not worn. A minimum recording of 8-hours/day (480-minutes/day) was the criteria to accept daily PA data as valid, as previously suggested [24, 25]. Participants were required to have a minimum of 3 days recorded data, in accordance with previous researchers [25, 26].

The outcome variables were time (min/day) spent in each of the following categories: sedentary PA (0-100 Counts/min); light activity (101-2295 Counts/min); moderate activity (2296-4011 Counts/min) or vigorous activity (≥ 4012 Counts/min), according to Evenson cut-points [27], as previously suggested for studies with adolescents [28]. Moderate-to-vigorous PA (MVPA) was defined as the sum of Moderate PA and Vigorous PA.

2.6. Statistical Analysis

Descriptive statistics [mean, standard deviation, inter-quartile range (IQR) and frequencies] were used to describe the sample characteristics and the main outcomes of IPAQA and accelerometer.

After performing Kolmogorov-Smirnov normality tests, with Lilliefors significance correction, Mann-Whitney U test was used to compare differences between boys and girls, and between the two age groups: early adolescents, from 10 to 14 years, and the late adolescents from 15 to 19 years [29]. Spearman correlation coefficient was performed to assess the relation between time spent at each intensity level and total PA obtained by IPAQA and the accelerometer [30].

Finally, tertiles of IPAQA and accelerometer total PA and moderate to vigorous PA were calculated and the agreement between the two measurements was tested using Cohen's Kappa [30].

Data analysis was performed using IBM Statistical Package for Social Sciences, version 22 (SPSS Inc; Chicago, IL, USA). Statistical significance was set at $P<0.05$.

3. RESULTS

The 222 adolescents included mainly females (123; 55.4%) and adolescents above 15 years of age (147; 66.2%). The mean BMI was 22.2 (SD=3.47) kg/m^2, with 77.0% having normal weight for height, age and gender [21]. There were no statistically significant differences in the younger age group (≤ 14 years) between boys and girls, regarding height, weight, BMI, and waist circumference Table **1**. In older age group (15 years or older), boys had a significantly higher weight ($Z=-3.313$; $P<0.001$) and height ($Z=-7.012$; $P<0.001$), but no significant differences were found for BMI Table **2**.

According to IPAQA, adolescents engaged on average 138.2 minutes (SD=106.95) in total PA daily. The total daily PA was divided up into 42.4 minutes (SD=48.61) moderate PA, 34.4 minutes (SD=36.07) vigorous PA, and in 61.4 minutes (SD=54.26) walking. No statistical differences between boys and girls were found in the reported PA for adolescents aged 14 years or under Table **1**, and for the older adolescents differences were significant ($Z=-2.796$; $P<0,01$) only for the time reported in vigorous PA, with boys reporting more time than girls Table **2**.

The accelerometer was used on average for 809.4 (SD=79.63) minutes/ day; sedentary, vigorous, moderate and light activity represented on average 506.9 (SD=117.61), 12.9 (SD=12.01), 35.1 (SD=19.27) and 277.7 (SD=72.40) minutes per day, respectively. In both age groups, boys spent significantly more time in vigorous and moderate PA than girls Tables (**1** and **2**).

Considering accelerometer measured time, younger boys ($Z=-4.450$; $P<0.001$) and girls ($Z=-4.244$; $P<0.001$) spent significantly more time in moderate PA than older boys and girls. The same was observed for MVPA: younger boys ($Z=-2.733$; $P<0.01$) and younger girls ($Z=-3.054$; $P<0.01$) spent more time in that intensity when compared to the older adolescents.

Spearman correlations between reported PA time (IPAQA) and measured time (accelerometer) revealed that, for the total sample Table **3**: the total time reported with IPAQA had no significant correlation to the total time assessed with accelerometer; the minutes per day reported in vigorous PA according to IPAQA was poorly correlated to the time measured with accelerometer in the same intensity level ($\rho=0.214$; $P<0.01$), and moderately correlated to the time spent in moderate PA ($\rho=0.338$; $P<0.01$); reported and measured time in MVPA had a poor correlation ($\rho=0.250$; $P<0.01$); and the total PA (MET/day) according to IPAQA was significantly correlated ($\rho=0.237$; $P<0.01$) to the total PA (counts/min) according to accelerometer, however this was a poor correlation.

Younger adolescent girls Table **4** show moderate correlations between measured MVPA time and walking time reported with IPAQA ($\rho=0.407$; $P<0.05$). In this group, walking time had also a moderate correlation with total PA counts from the accelerometer ($\rho=0.412$; $P<0.05$).

There were no meaningful correlations in the younger boys group Table **4**.

For adolescent girls 15 years and older, the total PA (steps/day) measured with accelerometer was significantly correlated with walking time ($\rho=0.323$; $P<0.01$), with vigorous PA ($\rho=0.286$; $P<0.01$), with MVPA ($\rho=0.251$; $P<0.05$) and with IPAQA total PA ($\rho=0.286$; $P<0.01$) Table **4**.

In the older adolescent boys group, the minutes per day reported in vigorous PA according to IPAQA were significantly correlated to the time measured with accelerometer on the same intensity level ($\rho=0.428$; $P<0.01$), and in the moderate intensity ($\rho=0.363$; $P<0.01$); when considering MVPA, the time per day according to IPAQA was significantly correlated ($\rho=0.428$; $P<0.01$) to the one measured with accelerometer; the total PA (MET.min.day^{-1}) according to IPAQA was significantly correlated ($\rho=0.372$; $P<0.01$) to the total PA (counts/min) according to accelerometer, though this was a poor correlation; there was no significant correlation between moderate PA level obtained by the two methods, however reported moderate PA was correlated with measured vigorous PA ($\rho=0.321$; $P<0.05$) Table **4**.

The tertiles agreement Table **5** between the accelerometer and the questionnaire for total PA was 42.3% ($K=0.135$; $P<0.01$); and for MVPA tertiles there was a 39.6% agreement ($K=0.094$; $P<0.05$).

Table 3. Spearman's Rank correlation coefficient of physical activity measured by the accelerometer and reported with IPAQA, for the total sample.

		Accelerometer							
		Total Measured Time (min.day^{-1})	**Sedentary PA (min.day^{-1})**	**Light PA (min.day^{-1})**	**Moderate PA (min.day^{-1})**	**Vigorous PA (min.day^{-1})**	**MVPA (min.day^{-1})**	**Total PA (counts.min^{-1})**	**Total PA (steps.day^{-1})**
IPAQA	**Total Reported Time (min.day^{-1})**	.131	-.067	.174**	.184**	.143*	.185**	.205**	.226**
	Motor Transportation (min.day^{-1})	-.047	.098	-.108	-.121	.042	-.069	-.085	-.121
	Walking (min.day^{-1})	.063	-.05	.099	.067	.084	.085	.116	.072
	Moderate PA (min.day^{-1})	.103	-.078	.192**	.157*	.072	.126	.148*	.223**
	Vigorous PA (min.day^{-1})	.222**	-.042	.184**	.338**	.214**	.319**	.300**	.381**
	Total Reported Time (min.day^{-1})	.131	-.067	.174**	.184**	.143*	.185**	.205**	.226**
	MVPA (min.day^{-1})	.184**	-.064	.218**	.268**	.169*	.250**	.252**	.328**
	Total PA (MET.min.day^{-1})	.163*	-.063	.195**	.233**	.162*	.226**	.237**	.280**

Abbreviations: PA: Physical Activity; IPAQA: International Physical Activity Questionnaire for Adolescents; MVPA: Moderate to Vigorous Physical Activity; MET: Metabolic Equivalents. * Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

Table 4. Spearman's Rank correlation coefficient of physical activity measured by the accelerometer and reported with IPAQA, by age group and gender.

			Accelerometer															
			≤ 14 years								≥ 15 years							
			Total Measured Time (min.day^{-1})	**Sedentary PA (min.day^{-1})**	**Light PA (min.day^{-1})**	**Moderate PA (min.day^{-1})**	**Vigorous PA (min.day^{-1})**	**MVPA (min.day^{-1})**	**Total PA (counts.min^{-1})**	**Total PA (Steps.day^{-1})**	**Total Measured Time (min.day^{-1})**	**Sedentary PA (min.day^{-1})**	**Light PA (min.day^{-1})**	**Moderate PA (min.day^{-1})**	**Vigorous PA (min.day^{-1})**	**MVPA (min.day^{-1})**	**Total PA (counts.min^{-1})**	**Total PA (steps.day^{-1})**
IPAQA	**Girls**	**Total PA (min.day^{-1})**	.025	-.380*	.434*	.313	.146	.273	.363*	.199	.077	-.053	.139	.113	.122	.109	.153	.291**
		Motor Transportation (min.day^{-1})	.146	.297	-.227	-.243	.190	-.092	-.177	.004	-.005	0	-.010	.058	.065	.088	.026	-.057
		Walking (min.day^{-1})	.150	-.187	.332	.421*	.170	.407*	.412*	.142	.072	-.100	.188	.131	.142	.147	.217*	.323**
		Moderate PA (min.day^{-1})	-.043	-.413*	.415*	.182	.055	.094	.186	.152	.109	-.011	.154	.050	.087	.050	.076	.182
		Vigorous PA (min.day^{-1})	.038	-.245	.279	.037	.035	.038	.158	.002	.146	.060	.028	.190	.115	.134	.095	.286**
		MVPA (min.day^{-1})	-.024	-.376*	.366*	.109	.048	.072	.200	.135	.137	.002	.145	.114	.108	.091	.110	.251*
		Total PA (MET.min.day^{-1})	.027	-.367*	.387*	.250	.108	.212	.317	.169	.097	-.029	.129	.129	.114	.107	.139	.286**
	Boys	**Total PA (min.day^{-1})**	-.054	-.100	.028	-.077	-.054	-.082	-.011	-.175	.24	.086	.050	.311*	.478**	.396**	.346**	.376**
		Motor Transportation (min.day^{-1})	-.121	-.089	-.106	.146	.183	.16	.296	.152	.095	.071	.034	-.169	-.037	-.141	-.111	-.038
		Walking (min.day^{-1})	.041	-.051	.140	.099	-.008	.062	.105	-.164	.102	.022	-.020	.220	.345**	.281*	.256	.244
		Moderate PA (min.day^{-1})	-.109	-.181	.013	.060	-.079	.028	.109	.075	.237	.026	.132	.209	.321*	.224	.182	.315*
		Vigorous PA (min.day^{-1})	.037	.049	-.005	-.328*	-.089	-.277	-.253	-.239	.257	.086	.178	.363**	.428**	.425**	.397**	.434**
		MVPA (min.day^{-1})	-.097	-.117	-.038	-.156	-.062	-.138	-.071	-.12	.313*	.077	.179	.352**	.489**	.428**	.375**	.463**
		Total PA (MET.min.day^{-1})	-.042	-.086	.026	-.146	-.05	-.131	-.065	-.185	.281*	.104	.110	.334*	.489**	.420**	.372**	.418**

Abbreviations: PA: Physical Activity; IPAQA: International Physical Activity Questionnaire for Adolescents; MVPA: Moderate to Vigorous Physical Activity; MET: Metabolic Equivalents. * Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

4. DISCUSSIONS

The present paper describes the translation and validation for the IPAQA in Portuguese adolescents. The original IPAQA was developed in 2008, in an international study including several countries, but not Portugal [16]. Although some Portuguese investigation has been carried out with adolescents using this questionnaire [12, 13], its validation has

not been performed in Portuguese adolescents yet.

Table 5. Tertiles classification percentage of agreement and Cohen's Kappa statistics, between IPAQA and Accelerometer.

	% Agreement	K	P-value
Total PA (MET.min.day^{-1} – Steps.day^{-1})	41.9	.128	**.007**
Total PA (MET.min.day^{-1} – Counts.min^{-1})	42.3	.135	**.004**
MVPA (min.day^{-1})	39.6	.094	**.047**

Abbreviations: IPAQA: International Physical Activity Questionnaire for Adolescents; PA: Physical Activity; MET: Metabolic Equivalents MVPA: Moderate to Vigorous Physical Activity.

The authors and the translation experts felt no need to change the content and structure of the questionnaire, finding it suitable for the age range and culture.

As with previous research on PA questionnaire validation, the accelerometers were used for concurrent validity [16, 17, 19, 31, 32].

This study has the advantage of using a GT3X+ model, which considers acceleration in 3 axes. By doing so, it guarantees the measurement of PA in the three dimensions of space, making it more accurate for PA measurement in free living conditions [33].

Data from the present study corroborate previous epidemiological studies [34, 35], where boys were significantly more active than girls and younger adolescents engaged significantly more time in MVPA than older adolescents, although IPAQA data failed to show these differences between sexes.

In this study no results are presented regarding the comparison between total time reported by IPAQA and measured by the accelerometer, as authors believe that the measures are not directly equivalent. One minute of IPAQA reported PA is not directly equivalent to one minute of measured PA. In fact this same conclusion was pointed out in studies with the adults version of IPAQ [36]. Additionally, the IQR also reveals that while IPAQA and accelerometer give information on physical activity, expressed in the same units, the two methods do have different scales. The present data are also in accordance with previous research that indicated that questionnaires overestimate time [32, 36], particularly in the higher intensity levels [19]. Indeed, in this sample a systematic error of over-reporting seems to exist. However, a previous attempt to validate a Swedish version of IPAQA pointed out the amount of unreported time as the explanation for the non-validation of the questionnaire [37]. Thus, considering the systematic error on the activities duration, IPAQA should not be used to evaluate compliance with the guidelines, expressed as minutes per day in a specific intensity level.

Similarly to this study, previous attempts to validate PA reporting methods for children and adolescents have consistently mentioned weak associations with accelerometer findings, especially if considering recall methods, and for light and moderate PA levels the associations tend to be particularly weak or inexistent [16, 17, 19, 32].

Sports participation, consistent with MVPA intensity, seems to be consistent over time (every week on the same day, with the same duration), making it easier to report and estimate duration, which may explain the significant correlation coefficient for physical activity in this intensity level, reinforcing the results from previous studies [16, 17, 19]. Considering that boys and older adolescents engage more in sports activities, while younger adolescents have more moments of spontaneous movement and PA, this has been mentioned [16] as a possible explanation for IPAQA having moderate correlation coefficients in the older adolescent boys group, but not in the other groups.

Difficulties in the full understanding of the concepts, as previously mentioned [16], is another possible reason for the low or non-existent correlations. Studies about the cognitive development of children and adolescents referred to the difficulty of reporting time duration of a certain activity, although there is an improvement in time sensitivity throughout childhood [38]. Considering that IPAQA asked specifically about the duration of specific physical activities, this might be one of the reasons why poor correlations were found, specifically for the younger adolescents. This notion is reinforced by research that concluded positively about the effect of motion on time perception [39].

Also related to the IPAQA concepts misunderstanding, the authors believe that adolescents cannot successfully distinguish between moderate and vigorous PA when filling in a questionnaire, which may explain why older boys IPAQA moderate time had a significant correlation coefficient (ρ=0.321; P<0.05) with accelerometer vigorous PA, but

no correlation with accelerometer moderate PA. Using a single category of moderate to vigorous physical activity (MVPA) may be useful to overcome this issue, and is in accordance with international guidelines for children and adolescents PA [40].

The concurrent validity proved that the IPAQA questionnaire might be valid when used to determine PA for older adolescent boys (≥15 years), but not with younger adolescents. The same conclusion was reached by the original version [16] and by other countries validation [19].

It is important to emphasize that although there was a weak correlation coefficient, the tertiles percentage of agreement showed that IPAQA could divide a sample in groups of PA, which is of particular interest to epidemiologists that frequently use categories of PA, instead of a quantitative approach. In addition, questionnaires are often a more practical data collection method than the high non-usage rates of instruments that require several day evaluations, such as accelerometers and pedometers [8 - 10].

The low accelerometer usage rate and the sample size, particularly when comparing groups, are assumed as limitations to this work.

CONCLUSION

IPAQA may be used in adolescent boys 15 years of age and older, to assess PA in a daily life context. For studies with large samples and budget constraints with no accelerometers availability, IPAQA can be a valid method of data collection. However, the authors would suggest to researchers that choose to use IPAQA that instead of working with time per day in each PA level, creating tertiles of PA may be a better option. This method would enable them to distinguish between more and less active adolescents; or alternatively, it would also be valid to combine moderate and vigorous physical activities into one single category (MVPA). Nevertheless, at this point the authors strongly discourage the use of IPAQA to assess PA in girls or in adolescents under 15 years old. In fact, the authors suggest that, whenever possible and available, objective methods should be used to assess PA in all adolescents. These findings call into question the conclusions of previous studies that used this questionnaire with Portuguese adolescents of all ages and sexes, enhancing the importance of validated tools as the only way of obtaining correct conclusions.

This study confirmed the validation of the first version of IPAQA for Portuguese older adolescent boys, nevertheless, further studies and additional efforts are needed to improve IPAQA and to make it valid for girls, younger adolescents and children.

LIST OF ABBREVIATIONS

PA	=	Physical Activity
IPAQ	=	International Physical Activity Questionnaire
IPAQA	=	International Physical Activity Questionnaire for Adolescents
BMI	=	Body Mass Index
MVPA	=	Moderate-to-Vigorous Physical Activity

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

all procedures involving human participants were approved by the Research Centre in Physical Activity, Health and Leisure Scientific Committee.

HUMAN AND ANIMAL RIGHTS

This study was conducted according to the guidelines defined in the Declaration of Helsinki.

CONSENT FOR PUBLICATION

Written informed consent was obtained from all the parents or legal guardians.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

Declared none.

REFERENCE

[1] Biddle SJ, Asare M. Physical activity and mental health in children and adolescents: a review of reviews. Br J Sports Med 2011; 45(11): 886-95.
[http://dx.doi.org/10.1136/bjsports-2011-090185] [PMID: 21807669]

[2] Boreham CA, McKay HA. Physical activity in childhood and bone health. Br J Sports Med 2011; 45(11): 877-9.
[http://dx.doi.org/10.1136/bjsports-2011-090188] [PMID: 21807670]

[3] Chimen M, Kennedy A, Nirantharakumar K, Pang TT, Andrews R, Narendran P. What are the health benefits of physical activity in type 1 diabetes mellitus? A literature review. Diabetologia 2012; 55(3): 542-51.
[http://dx.doi.org/10.1007/s00125-011-2403-2] [PMID: 22189486]

[4] Shiroma EJ, Lee I-M. Physical activity and cardiovascular health: lessons learned from epidemiological studies across age, gender, and race/ethnicity. Circulation 2010; 122(7): 743-52.
[http://dx.doi.org/10.1161/CIRCULATIONAHA.109.914721] [PMID: 20713909]

[5] Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act 2010; 7(1): 40.
[http://dx.doi.org/10.1186/1479-5868-7-40] [PMID: 20459784]

[6] Vanhelst J, Hardy L, Gottrand F, Béghin L. Technical aspects and relevance of physical activity assessment in children and adolescents in free-living conditions. Arch Pediatr 2012; 19(11): 1219-25.
[http://dx.doi.org/10.1016/j.arcped.2012.08.020] [PMID: 23037582]

[7] Rowlands AV, Eston RG. The measurement and interpretation of children's physical activity. J Sports Sci Med 2007; 6(3): 270-6.
[PMID: 24149412]

[8] Van Coevering P, Harnack L, Schmitz K, Fulton JE, Galuska DA, Gao S. Feasibility of using accelerometers to measure physical activity in young adolescents. Med Sci Sports Exerc 2005; 37(5): 867-71.
[http://dx.doi.org/10.1249/01.MSS.0000162694.66799.FE] [PMID: 15870643]

[9] Audrey S, Bell S, Hughes R, Campbell R. Adolescent perspectives on wearing accelerometers to measure physical activity in population-based trials. The European Journal of Public Health. 2012
[PMID: 23132872]

[10] Ottevaere C, Huybrechts I, De Meester F, De Bourdeaudhuij I, Cuenca-Garcia M, De Henauw S. The use of accelerometry in adolescents and its implementation with non-wear time activity diaries in free-living conditions. J Sports Sci 2011; 29(1): 103-13.
[http://dx.doi.org/10.1080/02640414.2010.521169] [PMID: 21104522]

[11] Lacy KE, Allender SE, Kremer PJ, *et al.* Screen time and physical activity behaviours are associated with health-related quality of life in Australian adolescents. Qual Life Res 2012; 21(6): 1085-99.
[http://dx.doi.org/10.1007/s11136-011-0014-5] [PMID: 21932139]

[12] Lopes VP, Gabbard C, Rodrigues LP. Physical Activity in Adolescents: Examining Influence of the Best Friend Dyad. The J Adolesc. Health : Off. Publ. Soc. Adolesc. Med. 2013; 52(6): 752-6.

[13] Araújo-Soares V, McIntyre T, MacLennan G, Sniehotta FF. Development and exploratory cluster-randomised opportunistic trial of a theory-based intervention to enhance physical activity among adolescents. Psychol Health 2009; 24(7): 805-22.
[http://dx.doi.org/10.1080/08870440802040707] [PMID: 20205028]

[14] Craig CL, Marshall AL, Sjöström M, *et al.* International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003; 35(8): 1381-95.
[http://dx.doi.org/10.1249/01.MSS.0000078924.61453.FB] [PMID: 12900694]

[15] Physical activity guidelines for children and youth. Canadian journal of public health = Revue canad 2007; 98(Suppl 2): S109-21.

[16] Hagströmer M, Bergman P, De Bourdeaudhuij I, *et al.* Concurrent validity of a modified version of the International Physical Activity Questionnaire (IPAQ-A) in European adolescents: The HELENA Study. Int J Obes 2008; 32(32)(Suppl. 5): S42-8.
[http://dx.doi.org/10.1038/ijo.2008.182] [PMID: 19011653]

[17] Lachat CK, Verstraeten R, Khanh NB, *et al.* Validity of two physical activity questionnaires (IPAQ and PAQA) for Vietnamese adolescents in rural and urban areas. Int J Behav Nutr Phys Act 2008; 5: 37.
[http://dx.doi.org/10.1186/1479-5868-5-37] [PMID: 18616798]

[18] Rangul V, Holmen TL, Kurtze N, Cuypers K, Midthjell K. Reliability and validity of two frequently used self-administered physical activity questionnaires in adolescents. BMC Med Res Methodol 2008; 8: 47.
[http://dx.doi.org/10.1186/1471-2288-8-47] [PMID: 18627632]

[19] Guedes DP, Lopes CC, Guedes JE. Reprodutibilidade e validade do Questionário Internacional de Atividade Física em adolescentes. Rev Bras Med Esporte 2005; 11: 151-8.
[http://dx.doi.org/10.1590/S1517-86922005000200011]

[20] Marshall A, Bauman A. The International Physical Activity Questionnaire: Summary Report of the Reliability & Validity Studies: IPAQ Executive Committee 2001. [14.07.2014]. Available from: http://www.ipaq.ki.se/questionnaires/IPAQSummaryReport03-01.pdf

[21] Ogden CL, Kuczmarski RJ, Flegal KM, *et al.* Centers for Disease Control and Prevention 2000 growth charts for the united states: improvements to the 1977 National Center for Health Statistics version. Pediatrics 2002; 109(1): 45-60.
[http://dx.doi.org/10.1542/peds.109.1.45] [PMID: 11773541]

[22] Thomas JR, Nelson JK, Silverman SJ. Research Methods in Physical Activity. Human Kinetics 2011.

[23] Choi L, Liu Z, Matthews CE, Buchowski MS. Validation of accelerometer wear and nonwear time classification algorithm. Med Sci Sports Exerc 2011; 43(2): 357-64.
[http://dx.doi.org/10.1249/MSS.0b013e3181ed61a3] [PMID: 20581716]

[24] Hobin E, So J, Rosella L, Comte M, Manske S, McGavock J. Trajectories of Objectively Measured Physical Activity among Secondary Students in Canada in the Context of a Province-Wide Physical Education Policy: A Longitudinal Analysis. J Obes 2014; 2014
[http://dx.doi.org/10.1155/2014/958645]

[25] Ottevaere C, Huybrechts I, De Bourdeaudhuij I, Sjostrom M, Ruiz JR, Ortega FB, *et al.* Comparison of the IPAQ-A and actigraph in relation to VO2max among European adolescents: the HELENA study. J sci med sport / Sports Med Aust 2011; 14(4): 317-24.
[http://dx.doi.org/10.1016/j.jsams.2011.02.008]

[26] Sardinha LB, Baptista F, Ekelund U. Objectively measured physical activity and bone strength in 9-year-old boys and girls. Pediatrics 2008; 122(3): e728-36.
[http://dx.doi.org/10.1542/peds.2007-2573] [PMID: 18762509]

[27] Evenson KR, Catellier DJ, Gill K, Ondrak KS, McMurray RG. Calibration of two objective measures of physical activity for children. J Sports Sci 2008; 26(14): 1557-65.
[http://dx.doi.org/10.1080/02640410802334196] [PMID: 18949660]

[28] Trost SG, Loprinzi PD, Moore R, Pfeiffer KA. Comparison of accelerometer cut points for predicting activity intensity in youth. Med Sci Sports Exerc 2011; 43(7): 1360-8.
[http://dx.doi.org/10.1249/MSS.0b013e318206476e] [PMID: 21131873]

[29] Sawyer SM, Afifi RA, Bearinger LH, *et al.* Adolescence: a foundation for future health. Lancet 2012; 379(9826): 1630-40.
[http://dx.doi.org/10.1016/S0140-6736(12)60072-5] [PMID: 22538178]

[30] Raykov T, Marcoulides GA. Introduction to psychometric theory. New York, NY, US: Routledge/Taylor & Francis Group 2011.

[31] Boon RM, Hamlin MJ, Steel GD, Ross JJ. Validation of the New Zealand Physical Activity Questionnaire (NZPAQ-LF) and the International Physical Activity Questionnaire (IPAQ-LF) with accelerometry. Br J Sports Med 2010; 44(10): 741-6.
[http://dx.doi.org/10.1136/bjsm.2008.052167] [PMID: 18981036]

[32] Wong SL, Leatherdale ST, Manske SR. Reliability and validity of a school-based physical activity questionnaire. Med Sci Sports Exerc 2006; 38(9): 1593-600.
[http://dx.doi.org/10.1249/01.mss.0000227539.58916.35] [PMID: 16960520]

[33] Plasqui G, Joosen AM, Kester AD, Goris AH, Westerterp KR. Measuring free-living energy expenditure and physical activity with triaxial accelerometry. Obes Res 2005; 13(8): 1363-9.
[http://dx.doi.org/10.1038/oby.2005.165] [PMID: 16129718]

[34] Baptista F, Santos DA, Silva AM, *et al.* Prevalence of the Portuguese population attaining sufficient physical activity. Med Sci Sports Exerc 2012; 44(3): 466-73.
[http://dx.doi.org/10.1249/MSS.0b013e318230e441] [PMID: 21844823]

[35] Mota J, Valente M, Aires L, Silva P, Santos MP, Ribeiro JC. Accelerometer cut-points and youth physical activity prevalence. Eur Phys Educ Rev 2007; 13(3): 287-99.
[http://dx.doi.org/10.1177/1356336X07081795]

[36] Celis-Morales CA, Perez-Bravo F, Ibañez L, Salas C, Bailey ME, Gill JM. Objective vs. self-reported physical activity and sedentary time: effects of measurement method on relationships with risk biomarkers. PLoS One 2012; 7(5): e36345.
[http://dx.doi.org/10.1371/journal.pone.0036345] [PMID: 22590532]

[37] Arvidsson D, Slinde F, Hulthèn L. Physical activity questionnaire for adolescents validated against doubly labelled water. Eur J Clin Nutr 2005; 59(3): 376-83.
[http://dx.doi.org/10.1038/sj.ejcn.1602084] [PMID: 15536471]

[38] Droit-Volet S. Time perception in children: A neurodevelopmental approach. Neuropsychologia 2013; 51(2): 220-34.
[http://dx.doi.org/10.1016/j.neuropsychologia.2012.09.023] [PMID: 22999968]

[39] Kroger-Costa A, Machado A, Santos JA. Effects of motion on time perception. Behav Processes 2013; 95: 50-9. [http://dx.doi.org/10.1016/j.beproc.2013.02.002] [PMID: 23454436]

[40] 2008 physical activity guidelines for Americans: be active, healthy, and happy!. U.S. Dept. of Health and Human Services 2008. Washington, D.C.