Cut-point values for classifying active children and validity and reliability of physical activity questionnaire for children in Morocco

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Abstract

Background: The Physical Activity Questionnaire for Children (PAQ-C) is widely used to assess physical activity in populations, however there is a lack of information about the psychometric properties (validity and reliability) and about the PAQ-C score meaning in populations from low-middle income countries

Aims: To evaluate the reliability and validity of PAQ-C and to determine the Cut-point values of PAQ-C using accelerometry as a reference in a group of Moroccan children.

Methods: In a sample of 171 children and adolescents aged 8 to 14 years, physical activity was assessed with the GT3X + accelerometer and the PAQ-C. PAQ-C was administered for a second time (retest) after 1 week for a subsample (n=73). Reliability was analyzed by the intraclass correlation coefficient (ICC). The PAQ-C was compared against count per minute CPM and moderate to vigorous intensity PA (MVPA) obtained by accelerometry. Receiver Operating Curve (ROC) analyzes were performed to assess the performance of PAQ-C in identifying MVPA as measured by accelerometry (reference method).

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Results: Test-retest reliability was poor with an ICC = (0.48 [0.27; 0.63] for the whole sample , while for the ≥ 11 years group the intra-class correlation coefficient was moderate (0.71 [0,42; 0,86]. PAQ-C scores were significantly related to accelerometry-derived metrics of physical activity, CPM (R = 0.*29,* p<0.001) and MVPA (R = 0.26, p<0.001). For the age group ≥11 years the associations between PAQ-C Scores and CPM and MVPA were stronger, respectively*, R=0.37 (p<0.001), R=0.38(p<0.0001).* We identified that a PAQ-C Score cut-point of 2.33 (95%CI (0.43–0.68)) discriminated adequately between those who met physical activity guidelines and those that did not in the overall sample.

Conclusions: The PAQ-C is valid and useful to assess population level physical activity in those ≥ 11 years in Morocco, and so might be helpful in population surveillance of physical activity in Moroccan adolescents.

Keywords: Physical activity; Accelerometer, PAQ-C, psychometric properties, Cut-Point, Validity, Morocco

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INTRODUCTION

Physical inactivity is a major public health problem and is the fourth leading risk factor for premature death in the world[1]. It is a leading risk factor for cardiovascular disease; type 2 diabetes, osteoporosis, and certain types of cancer[1]. Because of its importance to chronic disease prevention, attention has focused on developing interventions that promote physical activity and increase the number of children meeting the public health recommendations for physical activity [2-3]. The measurement of the impact of these interventions on physical activity is critical for studying and evaluating its health benefits[4]. Thus, valid and reliable measurement tools for measurement of physical activity are needed to better understand the impact of physical activity interventions[4-5].

Physical activity measurement tools are often categorized into objective (or 'device-based') and subjective measures[6]. Objective methods are widely used to assess PA in children[7]. They provide information about three of the four FITT (i.e. Frequency, Intensity, Time) components of physical activity considere by the World Health Organization (WHO)., and have the ability to capture different parameter such as number of steps, minutes of activity, and bouts of activity[8]. The commonly-used objective methods are wearable monitors such accelerometers, pedometers, and heart rate monitors. However, the use of wearable monitors is associated with several issues: inability to assess water-based activities, the absence of a consensus on data cleaning and processing and accelerometer cut points, and they are still relatively expensive for use in large populations[7]. Subjective methods include tools such as physical activity diaries and recall questionnaires, and are the most practical and economically feasible tool researchers can use to measure physical activity in large population-based studies [4-6-9]. There are several 'validated' physical activity questionnaires available for use with children. The PAQ-C was identified as potentially the most suitable questionnaire and has been recommended for use in children[34]. The PAQ-C involves a previous 7 day recall of

physical activity, and provides specific information about activity levels at different periods of the day (e.g. morning, lunch, recess, physical education, after school). The validity and reliability of the PAQ-C have been tested in different populations against other questionnaires or accelerometers[10-11-12]. The PAQ-C demonstrated acceptable psychometric properties [18-23] with an acceptable-to-good internal consistency, test–retest reliability, and sensitivity to detect gender differences [18-16-20-23]. The PAQ-C demonstrated moderate correlation with accelerometer scores, and in particular with MVPA in some studies[11-17-23-24-25-26-27]. The PAQ-C has been used in different countries and cultural contexts for research purposes, but the reliability and validity may not be constant across all populations[17-19-21-15-28], hence, it is crucial to consider factors such as ethnicity, race, language, cultural adaptation and validation, of the target population before the wide use of the PAQ-C in other countries like Morocco even in North African countries.

Furthermore, the numerical summary value generated by the PAQ-C (a continuous variable summarized as a single number) is not readily understood in terms of other more widely used summary values such as time spent in MVPA for example.

Thus, it is necessary to better understand and evaluate psychometric properties of the PAQ-C in Moroccan population, and what levels of PAQ-C are meaningful (e.g. in terms of meeting MVPA guidelines). The aims of this study are therefore to: determine the Cut-point values of PAQ-C for classifying active children as measured by accelerometry (average of 60 min/day of MVPA); measure the reliability and validity of PAQ-C in a group of Moroccan children.

METHODS

Participants:

Participants were a convenience of 175 children/adolescents aged between 8 to 14 years old, who were recruited from urban schools from three cities of Morocco. The study was carried out during the school-year.

Instrumentation and procedure

Anthropometric measurements

Anthropometric measurements were performed according to standardized procedures[13]. Weight was measured to the nearest 0.1 kg using a portable electronic scale (SECA "Seca GmbH & co.,", Hamburg, Germany) with the child barefoot and wearing light clothes. Height was measured to the nearest 0.1 cm using a stadiometer ("ShorrBoard, Portable Height-Length Measuring Board", LLC, Maryland, USA) with the child barefoot in a standing position. Body mass index (BMI) was calculated as the weight (kg) divided by the square of the height (m). BMI/age index were also calculated by using the WHO growth curve as reference [29].

Physical activity assessment by accelerometery

Physical activity was measured by using the ActiGraph GT3X+ (Pensacola, FL, USA) a triaxial accelerometer that captures movements in three axes (vertical, horizontal and perpendicular). ActiLife version 6.13.2 was used to initialize the GT3X+, to download and process the data collected.

GT3X+ initialization:

The accelerometer was initialized to collect data at a sampling frequency of 80 Hz during seven consecutive days starting from midnight of the first day of visit.

Wear instructions for the participants:

The participants were instructed to wear the accelerometer attached to an elasticized belt around the waist, positioned just above the right hip, from the time they woke up until bed time at night for 7 consecutive days and to remove the accelerometer any time they performed activities that involve the use of water such as bathing or swimming, and when going to bed.

Data post processing:

The accelerometer was set to collect raw uniaxial acceleration; these collected data were subsequently processed into 15sec epochs post download.

Wear time validation rules:

The ActiLife wear time validation program was used to determine the daily wear time. Periods of time above 60 minutes of consecutive zero counts were excluded as 'non-wear' time. A valid day was defined as a day with ≥ 600 min of registered data. For inclusion in the study, participants had to have at least 4 valid days of data (3 week days and 1 weekend day).[30]

Data scoring:

For valid accelerometry files, the ActiLife data scoring program was used to determine daily minutes spent in Sedentary time, light PA intensity (LPA), moderate PA intensity (MPA), vigorous PA intensity (VPA), and moderate to vigorous PA intensity (MVPA) for 15 second epoch length dataset (excluding non-wear time), using the Evenson activity cut points [14]. The accelerometer data were also expressed as counts per minute (cpm) as a measure of the total 'volume' of physical activity.

Physical activity by questionnaire

A week after the first visit, the PAQ-C questionnaire was administered to the participants. It's a self-administered, 7-day recall questionnaire that assesses participation in different physical activities, as well as activity during physical education, lunch break, recess, after school, in the evenings and at weekends[10].

The PAQ-C questionnaire has been designed for children and adolescents 8 to 14 years old; including 9 items, each scored between 1 (lower physical activity) and 5 (higher physical activity). The final score was an average of the 9 item scores. This score was computed using standard PAQ-C procedures as described by the developers of the PAQ-C[10].

A subset of 73 participants completed the PAQ-C again 1 week after completing the first questionnaire to assess test–retest reliability.

Data analysis

All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS, version 21) and results were considered significant at $p < 0.05$. The population was classified by age group:

- Age group < 11years (n=86) :8 to 11 years old were considered as children
- Age group ≥ 11 years (n=85): 11 to 14 years were considered as early adolescents according to Steinberg's developmental approach to adolescents [31].

The Kolmogorov-Smirnov test was performed to check if the variables had normal distribution, the variables with normal distribution were expressed as the mean with standard deviations, and the potential sex related differences in the data were analysed using unpaired t-tests. The Pearson correlation coefficient was computed to determine the association between the PAQ- C Score and various accelerometry-derived physical activity outcomes.

Test-retest reliability (stability over time) was assessed using intra-class correlation coefficients. Values less than 0.5, between 0.5 and 0.75, between 0.75 and 0.9, and greater than 0.90 are indicative of poor, moderate, good, and excellent reliability, respectively [35].

To assess whether a PAQ-C score cut-point can differentiate between individuals who meet physical activity guidelines (average of 60 min/day of MVPA), we generated a receiver operating curve (ROC), using PAQ-C scores as the classifier and meeting physical activity

guidelines as the true-status reference (an average of 60 min/d based on accelerometry). The accuracy of the diagnostic test derived from the ROC analysis is reflected by the area under the curve (AUC). Estimates of AUCs and their 95% confidence intervals (95% CI) were calculated. In case of a significant area under the curve, the coordinate with the greatest sum of sensitivity and specificity identifies the PAQ-C Score cut-point with discriminatory value.

RESULTS

Among the 175 children/adolescents recruited, 3 children were excluded from the analysis because of insufficient valid days, 1 child because of incompleted PAQ-C questionnaire, leaving a total of 171 children included in the analysis of validity and cut-points in the PAQ-C distribution.

Description of children characteristics.

General characteristics and physical activity outcomes of children by gender are shown in **Table 1.**

Children were aged between 8 to 14 years old (mean age = 10.92 ± 1.55 years), the mean BMI z-score was -0.16 ± 1.34. There were no significant differences in children's anthropometric and age characteristics according to gender.

Boys accumulated more accelerometer-measured MVPA compared to girls ($p<0.001$). The mean physical activity score determined by PAQ-C was 2.21 ± 0.60. Girls had a lower PAQ-C and re-PAQ-C score compared to boys ($p<0.001$).

According to age group, there were no significant differences in accelerometer-measured MVPA and retest-PAQ-C score. While the age group < 11 years had a higher PAQ-C score compared to the age group ≥ 11 years ($p <0.001$)

Association between PAQ-C and various accelerometry-derived physical activity outcomes

Associations between PAQ-C scores and CPM and MVPA are illustrated in **Figure 1**

There were significant correlations between PAQ-C Scores and CPM and MVPA (figure 1). The association was also examined according to age group, for the age group < 11years the association were lost, while for the age group ≥11years the association remained significant between PAQ-C Scores and CPM and MVPA time respectively, *R=0.37 (p<0.001), R=0.38 (p<0.0001).*

PAQ-C reliability test (test / re-test)

The test / re-test reliability of the PAQ-C is summarized in **Table 2.**

The intra-class correlation coefficient was 'low' to 'acceptable' for the entire sample (0.48 [0.27; 0.63]. However, when comparing by age group, the age group< 11 years had a 'low' intra-class correlation coefficient, while the age group ≥ 11 years had a 'moderate' intra-class correlation coefficient

PAQ cut-points: Meeting physical activity guidelines

The estimates of AUC and their 95% confidence intervals are presented in **Table 3.**

The ROC area under the curve (AUC) for the PAQ-C sample overall was 0.67 (95%CI 0.59–0.75), and the PAQ-C score with the greatest sum of sensitivity and specificity was 2.33, suggesting that this value may be used to crudely discriminate between individuals who are likely meeting physical activity guidelines and those who do not, (figure 2). The AUC was slightly higher in the older than younger children (Table 3).

The PAQ-C score that corresponded to the maximal AUC for meeting physical activity guidelines in the age group ≥ 11 years was lower 1.94 (AUC 0.75; 95%CI 0.65–0.85) , (figure 3) , while for the age group < 11 years the cut point was comparable to the cut-point identified for the overall sample at 2.33 (AUC 0.56; 95%CI 0.43–0.68), although this result was insignificant.

DISCUSSION

Main Findings and Implications

To describe the overall level of physical activity, a standardized, reliable and valid instrument is essential. In children and adolescents it is especially important to use instruments which are non-invasive and ease to use, with low participant and family burden. In addition, reliability and validity of the PAQ-C has been evaluated rarely in low-middle income countries. Therefore, we evaluated the reliability and validity of a French version of the PAQ-C in a convenience sample of children and adolescents aged between 8-14 years old in Morocco, tested whether reliability and validity varied by age within our sample, and identified a cut-off in PAQ-C values which might be useful in discriminating children and adolescents meeting WHO MVPA guidelines vs those not meeting guidelines. In this study, we report acceptable construct validity (based on correlations between PAQ-C and accelerometry), acceptable test-retest reliability for the whole sample, and a tentative cut-point in the PAQ-C distribution which might be a useful proxy for meeting/not meeting MVPA guidelines. Reliability, validity, and ability to discriminate those meeting vs not meeting MVPA guidelines were all higher in the older participants in our sample compared to the younger participants. Thus, our data suggests that the PAQ-C is valid and useful to assess population level physical activity in those ≥ 11 years in Morocco, and so might be helpful in population surveillance of physical activity in Moroccan adolescents.

Comparisons with Other Studies

Some comparisons of the physical activity levels according to the PAQ-C in the present study relative to other studies are possible. In our study, the mean PAQ-C score was 2.21 and this was generally lower than most other reports in the literature from children of similar age, e,g, from Tunisia (average PAQ-C score of 2.55) [15],from UK (Average PAQ-C score of 3.49) [16],

from Turkey (average PAQ-C score of 3.16) [19] and in various other studies, the PAQ-C score varied from 2.62 to 3.75 [10- 17-18]**.** As a result, Moroccan children recruited to the present study had lower PA levels than the children studies in other countries. The accelerometer measured levels of MVPA of children and adolescents in the present study are hard to compare with other studies because of differences in accelerometers used, and decisions made when handling accelerometry data, but mean MVPA levels observed were 56,95 ±26,17min/day roughly comparable to some other recent studies e,g, from Tunisia (59.77 ± 22.01 min/ day) [15], (62.80 ± 13.90) in Spanich children [21].

In the retest reliability analysis to assess the consistency of the scale over time, our results were generally lower (ICC = 0,47), compared to the results of other studies with children from LMICs, for example in Turkish children (n= 784; ICC = 0.91, 7 to 10 day for retest)[19] and Chinese children (n=784; ICC = 0.82, 7 to 10 day for retest) [17], also in comparison with Japanese children (n= 210, ICC= 0.83, 2 month for re-test) [32]. The lower ICC may be due to the small sample size [22], and it could be explained also by the difference in time between test and re-test. The recommended adequate time between test and re-test is more than one day but less than two weeks when using physical activity questionnaires [34]. Time between the two tests has an influence on reliability [23-33]. While, in our study when stratifying by age group, the ICC were moderate in the age group ≥ 11 years may have a better understanding of the concepts which the questionnaire focuses on because they have the required cognitive skills[20], and this may help explain the more consistent PAQ-C responses over time compared with younger children.

Our present study results on the construct validity of the PAQ-C are broadly consistent with studies in the literature which have reported a correlation coefficient between PAQ-C score and accelerometer-measured MVPA from 0.33 to 0.39 [10- 12-15-17]. It is of note that for a

Tunisian study the correlation was not significant[15], so there is a wide range of correlation coefficients in the literature. The difference between studies could be explained by the difference in sample size, by the different types of accelerometers used, by the difference in the protocol of accelerometer data processing used in each study e.g: epoch length or number of days recorded, and data analysis algorithms, cutoff point to identify PA intensities.

We found that the PAQ-C had moderate accuracy (area under the ROC curve 0.667) to discriminate between children who met physical activity guidelines of ≥60 minutes of MVPA per day versus those that did not, using accelerometry as the reference. Our optimal PAQ-C cut-off of 2.33 for the entire sample was slightly lower than other study using similar methodologies, e.g. in Spanish children the optimal cut-point was identified as 2.75 [21], this difference could be explained by the by the difference in the protocol of accelerometer data processing used. While In UK study the cutpoint of ≥2.9 was identified in boys and ≥2.7 were identified in a large study [11]. This difference may be due to different methodology used in the present study and/or differences in settings.

Strengths and Limitations of the study

The present work is novel, in Morocco, and it's the first study to assess the validity and reliability of PAQ-C against an objective method (accelerometry). In this study we respected the recommended adequate time interval between the two administrations. (ref) Otherwise, some limitations should be considered. First, the change in physical activity patterns between the two assessements. To overcome this limitation the both assessments were carried out during the same season and regular classes and were monitored by the same administrators. Thus, we considered that the influences by season, and different other condition were minimal in both assessments. Second; the study was conducted in urban regions, hence findings are not necessarily generalizable to other populations (rural, suburban). More studies are

recommended to further confirm the suitability of the PAQ-C for those age 11years and above in other settings.

Conclusion

The PAQ-C is valid and useful to assess population level physical activity in those ≥ 11 years in Morocco, and so might be helpful in population surveillance of physical activity in Moroccan adolescents.

IMPLICATIONS FOR SCHOOL HEALTH

There is considerable evidence regarding the impact of physical activity on youth development and health indeed accurate assessment of physical activity in schoolchildren is necessary to identify current levels of activity and to assess the effectiveness of intervention programs designed to increase physical activity. Thus, valid and reliable measurement tools for measurement of physical activity are needed. This manuscript presents novel data about validity and reliability of PAQ-C in Moroccan schoolchildren, and develop a PAQ-C cut point value that will help to identify MVPA guideline. The result of this study demonstrated that the PAQ-C would be helpful in population surveillance of physical activity in Moroccan schoolchildren.

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434 **Figures**

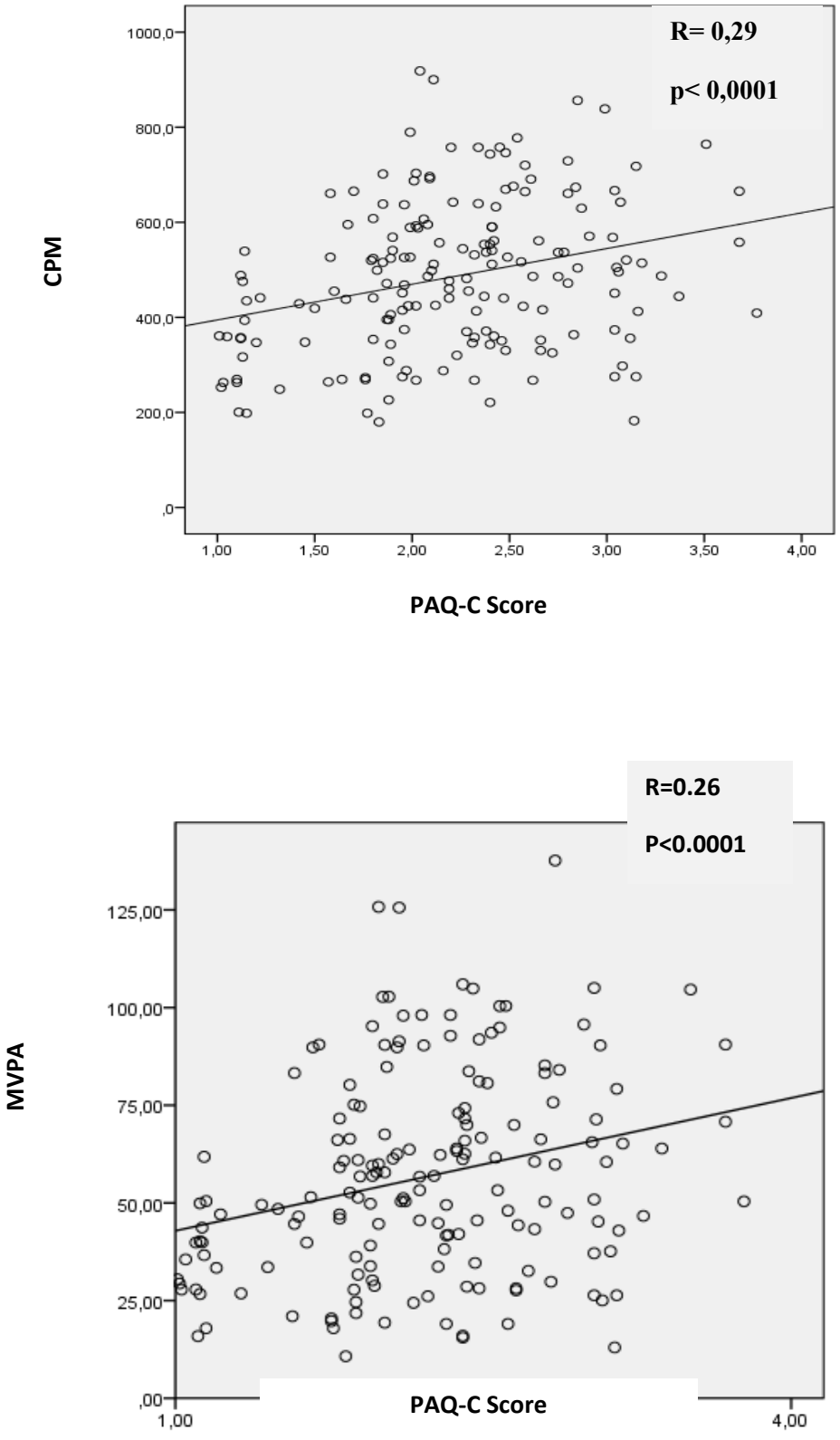

Figure 1: Association between PAQ- C Score and various accelerometry-derived physical activity outcomes (CPM and MVPA)

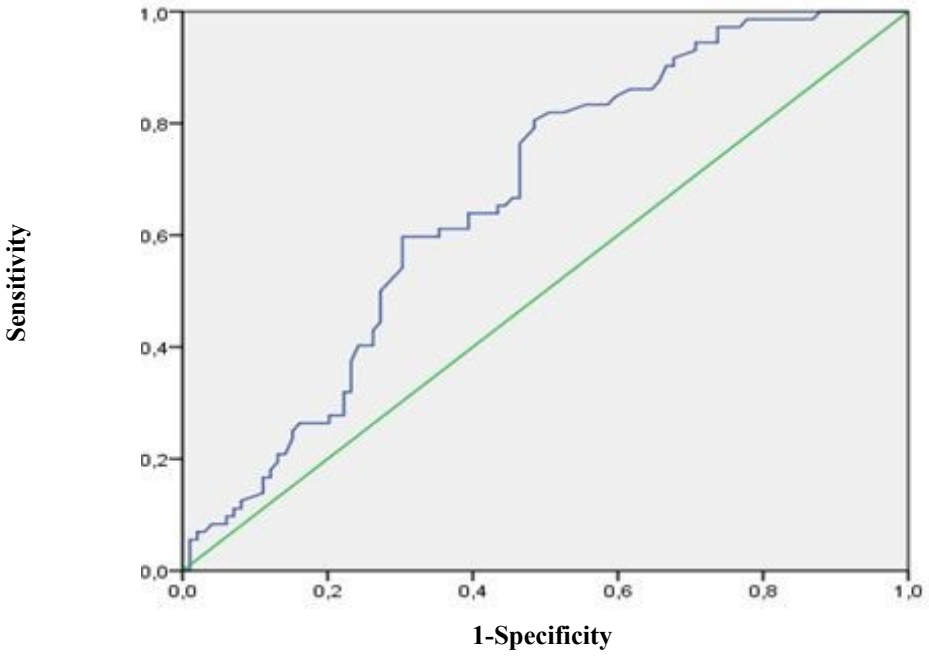

Figure 2: Receiver operating curve to identify PAQ-score cut-point that descriminates between those who meet physical activity guidelines (defined as ≥60 min MVPA/d based on accelerometry) versus those that do not, (Overall population).

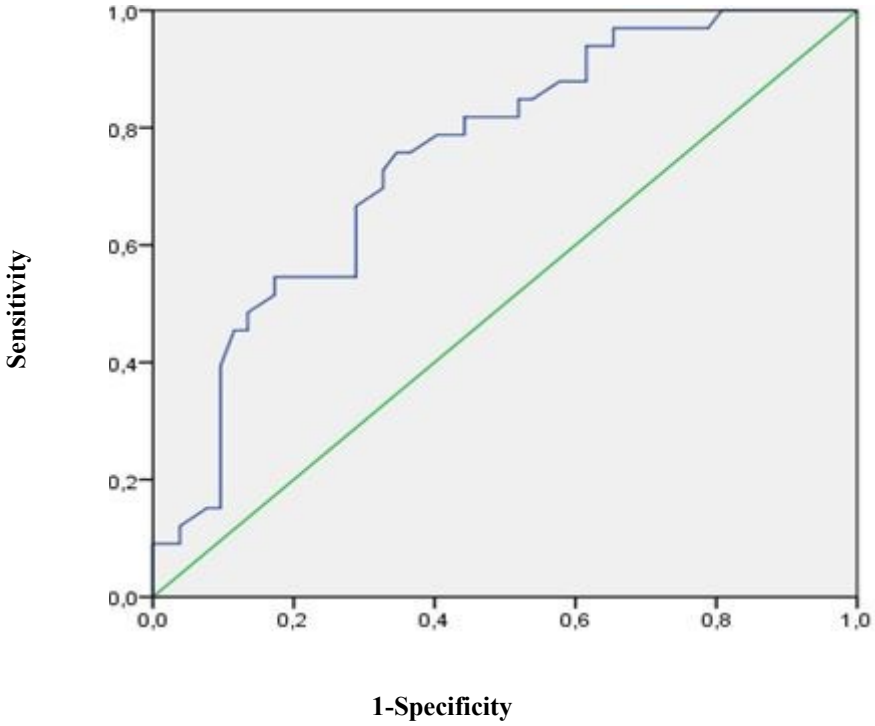

Figure 3: **Receiver operating curve to identify PAQ-score cut-point that descriminates between those who meet physical activity guidelines (defined as ≥60 min MVPA/d based on accelerometry) versus those that do not, (age group ≥ 11 years).**

500 **Tables:**

501 **Table 1:** General characteristics and physical activity outcomes of the children presented by
502 gender

	Total	Boys (n=85)	Girls (n=86)	p[a]
Age (years)	10.92 ± 1.55	10.89 ±1.50	10.94 ±1.62	0.83
Height (cm)	140,91±9,92	140,77±8,89	141,05±11,02	0,85
Weight (kg)	34.91 ± 9.46	34.05 ±7.06	35.77 ±11.33	0.23
BMI z-score	-0.16 ± 1.34	-0.18 ± 1.33	-0.14 ±1.35	0.85
HC	75,28 ±9,41	74,51±8,13	76,11±10,60	0,30
WC	61,33 ±7,97	61,42±7,38	61,24±8,60	0,89
HC/WC	0,81±0,06	0,82±0,06	0,80±0,06	0,08
MVPA (min/day)	56,95 ±26,17	68,66 ± 26,32	44,66 ± 19,88	<0,001
PAQ-C	2,21 ± 0,60	2,42 ± 0,51	1,99 ± 0,62	<0,001
Repeat-PAQ-C	2,30 ± 0,50	2,57 ± 0,53	2,06 ± 0,35	<0,001

503 *Value are mean ± SD, p- value relate to gender difference, p- value derived using t-test. BMI:*
504 *body mass index, HC: Hip circumference, WC: waist circumference, MVPA: moderate to*
505 *vigourous physical activity.*

506 **Table 2**: Reliability of the PAQ-C (test and Re-test)

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		95% Confidence interval	
	ICC	Lower limit	Upper limit
Overall(n=73)	0,48	0,27	0,63
By age group			
Age group< 11 years	0,32	0,04	0,55
Age group ≥ 11 years	0,71	0,42	0,86

508 ICC: Intra-class correlation

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518 **Table 3:** The ROC and area under the curve (AUC) for the PAQ-C

	AUC	Standard error	P	95% Confidence interval	
				Lower limit	Lower limit
Overall (n=171)	0,67	0,04	<0,001	0,59	0,75
By Age group					
Age group< 11 years	0,56	0,06	0,37	0,43	0,68
Age group ≥ 11 years	0,75	0,05	<0,001	0,65	0,85

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