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Measuring validity and reliability of the Italian version of Physical Activity Questionnaire for Older Children in overweight and obese children

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The measure of daily physical activity (PA) is one of the most important topics in the field of health promotion. In addition, self-efficacy and enjoyment are significant factors that can foster adherence to physical activity during a person's lifetime. The present study aims to assess the validity and reliability of Physical Activity Questionnaire for Older Children-Italian version (PAQ-C-It) in a sample of normal weight, overweight, and obese children. Three studies were conducted to assess the (1) general characteristics of PAQ-C-It, (2) model fit and construct validity between PA, self-efficacy, and enjoyment, and (3) reliability and construct validity of PAQ-C-It in normal weight, overweight, and obese children. The sample involved a total of 914, 500, and 600 children (male = 466, female = 448) attending first grade of secondary school (age = 11–13 years), in the first, second and third study, respectively. Children were asked to respond to three scales: Physical Activity Questionnaire for Older Children (PAQ-C-It), the Perceived Physical Ability Scale (PPAS), and Physical Activity Enjoyment Scale (PACES). Then, explorative and confirmatory factor analyses were conducted to assess the validity and reliability of the PAQ-C-It by relating results with those of the other scales. The analysis showed acceptable value and internal consistency of items for the subscales ($\alpha > 0.7$), as well as the average variance extracted (>0.5) in both normal weight, overweight, and obese children. The results of the present study show that PAQ-C-It can be applied in the field of physical activity to measure adherence to physical activity and healthy behaviors. Moreover, self-efficacy and enjoyment are significant factors that can best promote adherence to PA. The present study can extend our knowledge about PAQ-C-It and open up new research avenues for driving interventions aimed at reducing sedentary behavior and improving PA in overweight and obese children.

KEYWORDS

physical activity, self-efficacy, enjoyment, obesity, children

1 Introduction

The benefits of physical activity (PA) from infancy to adulthood have been widely documented in international literature (Malm et al., 2019; Singh et al., 2020). Among them, there was an improvement in the functioning of the cardiovascular, respiratory, and immune systems (Barker et al., 2018), better neural adaptations and brain development (Di Liegro et al., 2019; Hillman et al., 2019), muscles and bones health, body weight management, and improve metabolism (Bourdier et al., 2023; Julian et al., 2022). Moreover, active lifestyles and adherence to physical activity during the lifetime lead to the reduction of cardiovascular diseases, type 2 diabetes, and other metabolic diseases (Barry et al., 2022), several types of cancer, that is, colon, stomach, lung, and bladder (Mao et al., 2022), and reduction in anxiety, stress, and depression (Singh et al., 2023). Despite the latest WHO guidelines (Bull et al., 2020) recommending a daily practice of at least 60 min of moderate to vigorous physical activity (MVPA) for children and adolescents, recent epidemiological studies showed that a large percentage of boys and girls (11–17 years) do not engage in enough physical activity because of the growing adoption of sedentary lifestyles and activities (Guthold et al., 2020; World Health Organization, 2023) so much that it has been defined as one of the most important health problems of the 21st century (Katzmarzyk, 2023; Blair, 2009). These data are even more worrying if considered in the light of the effects of the recent COVID-19 pandemic. During lockdown, restrictive measures and quarantine have led to a further reduction in physical activity levels (Caputo and Reichert, 2020; Robinson et al., 2021; Zenic et al., 2020), and the corresponding increase in depression, anxiety, and eating disorders in the younger population (Puccinelli et al., 2021; Ingram et al., 2020). Participation in physical activities contributes to motor skills development, necessary precursors of healthy lifestyles, sports participation, and different experiences increasing the quantitative and qualitative opportunities to be physically active (Hulteen et al., 2018). Therefore, the assessment of levels of physical activity represents an unavoidable need, especially in developmental age.

In scientific research, and especially in the educational sciences, levels of physical activity (how much I move) are often used as a mediating variable or as a means by which to explain the positive effects on health status in terms of physical fitness (Neil-Sztramko et al., 2021), psychological correlates, such as enjoyment, self-perception, and motivation (Kelso et al., 2020), cognitive function (Biino et al., 2023), and academic achievement (Heemskerk et al., 2023). However, a gold standard to assess the physical activity levels in children and adolescents does not exist yet. Several systematic reviews and meta-analyses are classified subjective (i.e., direct observation and self-report) and objective (i.e., direct and indirect calorimetry, accelerometry, and doubly labelled water) measures of physical activity, each one characterized by strengths and weakness (Kohl et al., 2000; Sirard and Pate, 2001; Sedlačík et al., 2023). Subjective tools, such as diaries and self-report, are often simple and low-cost methods compared to accelerometers and direct/indirect calorimetry. Moreover, they can be easily accessible, available for large samples, and show good validity and reliability as well as objective tools (Schmidt et al., 2008). However, since they are influenced by several factors, such as memory, race, and psychological mood, the results can be affected and not always accurate (Marasso et al., 2021).

On this topic, the Physical Activity Questionnaire for Older Children (PAQ-C) has been developed as valid tools to evaluate physical activity in primary schoolchildren of 4th to 8th grade (8–14 years) (Crocker et al., 1997; Kowalski et al., 1997). The questionnaire investigates the measures of moderate to vigorous physical activity during the school year, recalling activities performed in the last 7 days, so it is not appropriate to assess physical activity during holidays or summer (Crocker et al., 1997; Kowalski et al., 1997; Kowalski et al., 2004). The instrument consists of nine items (the questionnaire also has an item 10, but it is not considered for the calculation of total physical activity score), as follows:

- Item 1 (spare physical activity): children were asked to check how many times they practiced each activity during the last 7 days.
- Items 2 to 8: they refer to engagement during physical education, recess, lunch, right after school, evening, weekends, and personal physical activity profile description.
- Item 9: it describes physical activity during each day of the week.

Each item score ranged from 1 to 5 points. The composite score for items 1 and 9 can be obtained through the mean of all the activities and weekdays, respectively, and PAQ-C summary score is carried out by taking the mean of all the nine items (Kowalski et al., 2004). In addition to the assessment of general psychometric properties (Crocker et al., 1997; Kowalski et al., 1997), studies have evaluated PAQ-C validity and reliability in different countries and population, including those with special clinical conditions (Moore et al., 2007; Wang et al., 2016; Mohd Zaki et al., 2016; Gobbi et al., 2016; Voss et al., 2017; Isa et al., 2019; Cuberek et al., 2021; Sirajudeen et al., 2022; Makai et al., 2023). Despite the evidence, to the best of our knowledge, there's a lack of evidence supporting the validity and reliability of PAQ-C-It in overweight and obese children. The present contribution provides three studies (study 1: explorative factor analysis; study 2: construct validity for PAQ-C-It, self-efficacy and enjoyment, and study 3: psychometric properties of PAQ-C-It and two questionnaires for self-efficacy and enjoyment in overweight and obese children) to expand the knowledge and theoretical framework for measuring physical activity with PAQ-C-It in both overweight and obese children.

The present study is divided into three substitutes: the first is aimed at providing factor analysis of PAQ-C-It, the second is aimed at assessing structural and construct validity between PAQ-C, and two validated questionnaires on self-efficacy and enjoyment, and the third is aimed at evaluating the reliability and structural validity of three mentioned questionnaires in normal weight, overweight, and obese children.

2 Study 1

2.1 Aim and procedure

Study 1 aims to assess the general characteristics, reliability, and internal validity of PAQ-C-It. For this cross-sectional study, the sample ($N = 914$, male = 466, female = 448, age = 11–13 years) has been recruited from "Regional Observatory of Motor

Development Project" aimed at first-grade secondary schools in the Apulia region. A total of 914 children were selected using consecutive sampling with the following eligibility criteria to ensure better representation of the population: age 11–13 years and no cognitive or physical disability. Children were asked to complete an online version of the Italian version of PAQ-C-It questionnaire validated in previous the study by Gobbi et al. (2016) at school using computer or tablet and supervised by the teacher.

Before starting the assessment, PE teachers were involved in three training meetings (for a total of 9 h) to explain and standardize the assessment procedure. Data collection was carried out between October and November 2023, after receiving informed consent by the students involved.

2.2 Statistical analysis

In addition to mean and standard deviation, the sample's descriptive profile was carried out reporting minimum, maximum, and 95% confidence interval mean. For understanding the latent structure of the Physical Activity Questionnaire, an explorative factor analysis (EFA) was carried out to outline the meaningful factors and structural validity. Before starting analysis, the Kaiser–Meyer–Olkin (KMO) was used to assess the measures of sample adequacy (MSA). A value from 0.5 to 1 was considered acceptable. Then, Bartlett's test of sphericity was used to determine if the correlation matrix is not an identity matrix ($p < 0.05$). Multicollinearity was also assessed carrying out the correlation matrix between predictors. After verifying the EFA requirements, the principal component analysis based on Kaiser's criteria (eigenvalue >1) and varimax rotation has been performed. Cronbach's α coefficient was calculated for the reliability analysis, with α-values greater than 0.70 considered acceptable for the purposes of this study. The minimum factor loading criteria was set to 0.50. Furthermore, root mean square error of approximation (RMESA), standardized root mean square residual (SRMSR), comparative fit index (CFI), Tucker–Lewis index (TLI), and Bayesian information criterion (BIC) were also carried out to assess the general model fit. All statistical analysis has been conducted with SPSS version 26 and JASP. The significant index was set at $p < 0.01$.

2.3 Results of study 1

To assess the theoretical structure of PAQ-C-It, an EFA has been performed for evaluating the general characteristics, reliability, and internal consistency of factorial structure. The results from descriptive statistics are summarized in Table 1.

Bartlett's test ($\chi^2 = 2986.760$; $n = 36$) ($p < 0.01$) confirmed that the sample correlation matrix was not an identity matrix, and since MSA value was above 0.5 (MSA = 0.879), the appropriateness of the data for factor analysis is confirmed, and it can be inferred that sample is adequate to conduct further analysis. Cronbach's α (0.826) highlighted that model 1 has good reliability for EFA, and a significant correlation was observed between predictors with Pearson's $r < 0.08$, leading to the assumption that multicollinearity is not an issue (Table 2).

Factors were extracted by using the principal component analysis (PCA) and varimax rotation for getting non-overlapping factors. In this model, two factors were extracted, and the amount of the variance explained by these factors was about 48%. The eigenvalues of each factor have been reported: 4.045 for the first factor and 1.235 for the second, respectively (Table 3).

The factor loadings for all the variables have been reported in Table 4 after using varimax rotation. Variables with factor loadings of 0.5 or more have been retained in the factors. Only PAQ-C-It2 item showed a factor loading of 0.314, which is lower than the expected value of 0.5.

However, additional fit indices showed a good model fit, so the authors decided to include item 2 in further analysis. As can be seen in Table 5, the root mean square error of approximation (RMSEA) was 0.070, which is in line with the recommended value of <0.080. The standardized root mean square residual (SRMSR) was less than the critical value of 0.10, and both comparative fit index (CFI) and Tucker–Lewis index (TLI) were above the suggested value of 0.90, showing a good model fit. Moreover, a negative and small Bayesian

TABLE 1 Descriptive statistics.

Descriptive statistics						
	95% confidence interval mean		Mean	Std. deviation	Minimum	Maximum
	Upper	Lower				
PAQ-C-It 1	1.442	1.398	1.420	0.343	1.000	3.250
PAQ-C-It 2	4.137	4.017	4.077	0.924	1.000	5.000
PAQ-C-It 3	2.174	2.071	2.123	0.789	1.000	5.000
PAQ-C-It 4	1.462	1.347	1.404	0.886	1.000	5.000
PAQ-C-It 5	3.166	2.996	3.081	1.303	1.000	5.000
PAQ-C-It 6	2.510	2.340	2.425	1.305	1.000	5.000
PAQ-C-It 7	2.613	2.448	2.530	1.270	1.000	5.000
PAQ-C-It 8	2.763	2.602	2.682	1.238	1.000	5.000
PAQ-C-It 9	2.675	2.553	2.614	0.934	1.000	5.000
PAQ-C-It	2.528	2.440	2.484	0.675	1.000	4.573

TABLE 2 Correlation between predictors and multicollinearity.

Correlation matrix								
	PAQ-C-It2	PAQ-C-It3	PAQ-C-It4	PAQ-C-It5	PAQ-C-It6	PAQ-C-It7	PAQ-C-It8	PAQ-C-It9
PAQ-C-It1	0.217**	0.251**	0.257**	0.408**	0.443**	0.472**	0.332**	0.508**
PAQ-C-It2	/	0.124**	0.132**	0.233**	0.221**	0.208**	0.308**	0.312**
PAQ-C-It3		/	0.399**	0.225**	0.229**	0.233**	0.177**	0.204**
PAQ-C-It4			/	0.148**	0.188**	0.233**	0.156**	0.185**
PAQ-C-It5				/	0.643**	0.627**	0.622**	0.666**
PAQ-C-It6					/	0.580**	0.479**	0.621**
PAQ-C-It7						/	0.484**	0.581**
PAQ-C-It8							/	0.585**

* = $p < 0.05$ and ** = $p < 0.01$.

TABLE 3 Factors extraction.

Factor characteristics							
		Unrotated solution			Rotated solution		
	Eigenvalues	SumSq. loadings	Proportion var.	Cumulative	SumSq. loadings	Proportion var.	Cumulative
Factor 1	4.045	3.593	0.399	0.399	3.254	0.362	0.362
Factor 2	1.235	0.691	0.077	0.476	1.030	0.114	0.476

TABLE 4 Factor loadings applying varimax rotation.

Factor loadings		
	Factor 1	Factor 2
PAQ-C-It1	0.512	
PAQ-C-It2	0.314	
PAQ-C-It3		0.531
PAQ-C-It4		0.711
PAQ-C-It5	0.832	
PAQ-C-It6	0.732	
PAQ-C-It7	0.705	
PAQ-C-It8	0.684	
PAQ-C-It9	0.812	

information criterion (BIC) value can be considered acceptable for the present analysis.

3 Study 2

3.1 Aim and procedure

The findings revealed the mediating role of self-efficacy and enjoyment in enhancing and maintaining adherence to physical activity in children and adolescents (Crocker et al., 2000; Klos et al., 2020; Henning et al., 2022; Greule et al., 2024). Playful activities and high physical self-perception are both predictors of higher intrinsic motivation in PA (Ruiz-Montero et al., 2020). In this regard, study 2 aimed to assess the psychometric properties of the PAQ-C-It and construct validity with enjoyment and physical self-efficacy in a sample of 11- to 13-year-old children. The sample's recruitment, data collection, and physical education (PE) teachers' training were similar to the previous study. In this study, a total of 500 children completed an online version of the PAQ-C-It (Gobbi et al., 2016), Perceived Physical Ability Scale (Bortoli and Robazza, 1997), and Physical Activity Enjoyment Scale (PACES; Carraro et al., 2008) in addition to PA, self-efficacy, and enjoyment, respectively.

TABLE 5 Godness of fit indices.

Additional fit indices					
RMSEA	RMSEA 90% confidence	SRMSR	TLI	CFI	BIC
0.070	0.057–0.083	0.026	0.946	0.972	−26.622

3.2 Statistical analysis

The exploratory factor analysis were conducted to assess the structural validity of PAQ-C It and construct validity has been calculated through a correlation between PAQ-C It, PACES, and SE. In addition to descriptive statistics, the principal component analysis was conducted to examine the interrelation between latent variables. Cronbach's α coefficient was determined and the items-total correlation was performed. Furthermore, composite reliability (CR) value ($\geq$0.70) and average variance extracted (AVE) value ($\geq$0.50) were also carried out to test the questionnaire construct reliability and convergent validity. The construct validity was assessed

through Pearson's r coefficient between PAQ-C-It, PPAS, and PACES to highlight the significant relation between constructs and interpreting the results as follows: $r < 0.30$ = small correlation, $0.30 < r < 0.50$ = medium correlation, and $r > 0.50$ = large correlation. All statistical analysis has been conducted with SPSS version 26 and JASP. The significant index was set at $p < 0.01$.

3.3 Results of study 2

Descriptive statistic was reported for anthropometric data and questionnaires (Table 6).

The authors performed exploratory factor analysis to validate the nine-item Italian version of PAQ-C-It. The results revealed a two-factor model (Table 7). Using the maximum likelihood, factor loading for PAQ-C-It factor 1 showed an acceptable magnitude (>0.30) for all items, except for PAQ-C-It1. However, since all the indices were in the expected direction (AVE >0.50, CRI >0.6), the authors decided to keep Item 1 in the model. For factor 2, factor loadings, AVE, and CRI were all above the recommended value. Internal consistency for the two factors was acceptable, with $\alpha > 0.80$, with the item showing moderate to strong item-total correlation (r ranged from 0.413 to 0.822, $p < 0.01$). Then, researchers performed EFA for PPAS and PACES questionnaires (Table 7). EFA on PPAS produced a two-factor model, positive (factor 1) and negative (factor 2) items, respectively. All items in the two subscales showed factor loadings index above the suggested value. Since CRI ranged from 0.833 to 0.868 for factors 1 and 2, respectively, reliability as well as convergent validity can be demonstrated (AVE value were >0.50). Item-total correlation was also significant for all variables (r ranged from 0.576 to 0.685, $p < 0.01$), and Cronbach α suggested good internal consistency.

PACES analysis revealed a two-factors model: positive (item 1-4-6-8-9-10-11-14-15) and negative scale (item 2-3-5-7-12-13-16). Cronbach α exceeded the recommended value of 0.7 for both factors 1 and 2. Moreover, even if AVE was less than the threshold value of 0.5, good composite reliability ($CRI_{factor\ 1} = 0.870$, $CRI_{factor\ 2} = 0.823$) and convergent validity of the model can be considered adequate. CITs highlighted significant values ranging from 0.420 to 0.685, with $p < 0.01$.

Finally, various indices have been used to assess model fit for each questionnaire, indicating moderate to good fit (Table 8).

PAQ-C-It construct validity (Table 9) has been assessed through a significant correlation with PPAS ($r = 0.327$, $p < 0.001$) and PACES ($r = 0.258$, $p < 0.001$).

4 Study 3

4.1 Aim and procedure

The personal physical appearance and weight bias internalization could affect people's enjoyment, leading to a lower adherence to physical and sports activities (Bevan et al., 2021). Moreover, poor individual motivation and self-efficacy when practicing physical activity represent important constraints for overweight and obese children (Chen et al., 2023; Trecroci et al., 2021; Monacis et al., 2022a). Based on the results of studies 1 and 2, a third study was conducted to assess the general characteristics, reliability, internal validity, and factorial structure of PAQ-C It, PPAS, and PACES in a sample of overweight and obese children. The procedure assessment and methods were the same in study 2. Moreover, before starting the survey, anthropometric characteristics [age, weight, height, and body mass index (BMI)] were measured for each participant by physical education (PE) teachers. Then, they were classified as normal weight (Nw), overweight (Ow), and obese (Ob) according to the Cole et al. (2000) scale. This study involved a sample of 600 children clustering in groups of 100 according to BMI cutoff and gender (male Nw = 100, male Ow = 100, male Ob = 100, Nw = 100, female Ow = 100, female Ob = 100).

4.2 Statistical analysis

In study 3, the general characteristics of PAQ-C It, PPAS, and PACES have been investigated, assessing internal consistency, validity, and reliability in a sample of overweight and obese children. Starting from the results of study 2, confirmatory factor analysis (CFA) were conducted to explore the structure of the Italian version of the questionnaire in normal weight, overweight, and obese children. Descriptive analyses of items were examined separately for Nw, Ow, and Ob children according to gender. The model structure was assessed using several indices (X2, CFI, TLI, NFI, RMSEA, SRMSR, good of fitness (GFI), and Cronbach α). A 2 (gender) × 3 (cutoff value) multivariate analysis of variance (MANOVA) was performed to assess the effects on the three dependent variables (PAQ-C-It, PPAS, and PACES). Then, differences between male and female were evaluated with independent sample t-test, and one-way analysis of variance (ANOVA) was performed for BMI cutoff. Data were analyzed using SPSS version 26, and results were significant at $p < 0.05$.

TABLE 6 Anthropometric characteristics and questionnaires' descriptive statistics.

Descriptive statistics							
	Age	Height	Weight	BMI	PAQ-C-IT	PPAS	PACES
Mean	12.012	1.556	50.544	20.901	2.484	39.311	69.996
Std. error of mean	0.029	0.003	0.454	0.140	0.022	0.213	0.267
95% CI mean upper	12.069	1.562	51.434	21.176	2.528	39.730	70.519
95% CI mean lower	11.956	1.550	49.653	20.625	2.440	38.892	69.472
Std. deviation	0.870	0.091	13.036	4.241	0.675	6.445	8.061
Minimum	11.000	1.280	24.000	13.136	1.000	16.000	18.000
Maximum	13.000	1.820	100.000	42.458	4.573	50.000	80.000

TABLE 7 Measurement model.

	λ	CITs	AVE	CR	Cronbach α
PAQ-C-It—factor 1					
PAQ-C-It1	0.195	0.586**	0.535	0.883	0.843
PAQ-C-It2	0.308	0.452**			
PAQ-C-It5	1.079	0.822**			
PAQ-C-It6	0.991	0.783**			
PAQ-C-It7	0.942	0.779**			
PAQ-C-It8	0.858	0.742**			
PAQ-C-It9	0.762	0.800**			
PAQ-C-It—factor 2					
PAQ-C-It3	0.539	0.435**	0.664	0.798	0.868
PAQ-C-It4	0.518	0.413**			
PPAS—factor 1					
PPAS1	0.764	0.657**	0.603	0.883	0.825
PPAS3	0.712	0.590**			
PPAS5	0.849	0.680**			
PPAS7	0.754	0.576**			
PPAS9	0.797	0.626**			
PPAS—factor 2					
PPAS2	0.778	0.646**	0.569	0.868	0.847
PPAS4	0.729	0.685**			
PPAS6	0.820	0.630**			
PPAS8	0.716	0.644**			
PPAS10	0.727	0.673**			
PACES—factor 1			0.427	0.870	0.839
PACES_1	0.617	0.638**			
PACES_4	0.552	0.662**			
PACES_6	0.534	0.585**			
PACES_8	0.631	0.685**			
PACES_9	0.681	0.609**			
PACES_10	0.536	0.522**			
PACES_11	0.564	0.610**			
PACES_14	0.576	0.579**			
PACES_15	0.646	0.670**			
PACES—factor 2			0.430	0.823	0.761
PACES_2	0.601	0.551**			
PACES_3	0.655	0.544**			
PACES_5	0.658	0.502**			
PACES_7	0.520	0.424**			
PACES_12	0.397	0.420**			
PACES_13	0.621	0.476**			
PACES_16	0.475	0.458**			

λ, factor loading; CITs, corrected item-total correlations; AVE, average variance extracted; CR, composite reliability. ** = $p < 0.01$.

4.3 Results of study 3

Descriptive statistics of anthropometric characteristics and questionnaires have been reported in Table 10.

CFAs have been conducted for each questionnaire assessing the internal consistency, validity, and reliability in normal weight, overweight, and obese children (Table 11). Chi-square index was highly significant for all questionnaires both for normal weight, overweight, and obese groups ($p < 0.001$). Only PAQ-C-It and PPAS in obese samples showed less significant values with $p < 0.05$. CFI and TLI index exceeded the recommended value for PAQ-C-It, PPAS, and PACES in the normal weight group ($CFI_{PAQ\text{-}C\text{-}It} = 0.945$, $CFI_{PPAS} = 0.958$; $TLI_{PAQ\text{-}C\text{-}It} = 0.923$, $TLI_{PPAS} = 0.944$, $CFI_{PACES} = 0.927$, $TLI_{PACES} = 0.910$), overweight ($CFI_{PAQ\text{-}C\text{-}It} = 0.954$, $CFI_{PPAS} = 0.923$; $TLI_{PAQ\text{-}C\text{-}It} = 0.937$, $TLI_{PPAS} = 0.898$that is closed to 0.90; $CFI_{PACES} = 0.928$, $TLI_{PACES} = 0.900$), and obese groups ($CFI_{PAQ\text{-}C\text{-}It} = 0.965$, $CFI_{PPAS} = 0.972$; $TLI_{PAQ\text{-}C\text{-}It} = 0.951$, $TLI_{PPAS} = 0.963$; $CFI_{PACES} = 0.925$, $TLI_{PACES} = 0.905$). NFI values were above 0.85 for all variables in all the groups. RMSEA and SRMSR were also in the expected directions (RMSEA <0.08, SRMSR <0.080). Moreover, GFI and Cronbach α were above the recommended value of 0.95 and 0.70, respectively, independently of BMI cutoff.

Since Box's M test of 37.325 was not significant ($p = 0.184$), the homogeneity of covariance matrices, linearity, and multicollinearity [$F(30, 158701.456) = 1.226$] across the groups was assumed.

Using Wilks' criterion, multivariate analysis (Table 12) showed that main effect for gender [Wilks' $\lambda = 0.946$, $F(3, 905) = 17.376$, $p < 0.001$, $\eta_p^2 = 0.054$] and BMI cutoff [Wilks' $\lambda = 0.937$, $F(6, 1810) = 10.059$, $p < 0.001$, $\eta_p^2 = 0.032$] were significant, while the interaction effect was not statistically significant [Wilks' $\lambda = 0.994$, $F(6, 1810) = 0.909$, $p = 0.487$, $\eta_p^2 = 0.003$].

Next, to investigate the simple effect on each dependent variable (PAQ-C-IT-C, PPAS, and PACES) an ANOVA with alpha-level set at $p < 0.05$ was performed. Pairwise comparison (Table 13) revealed significant differences between Nw and Ob children for PAQ-C-IT ($p < 0.01$) and PACES ($p < 0.01$). The main effect of BMI cutoff was also significant on both Nw vs. Ow ($p < 0.001$), Nw vs. Ob ($p < 0.001$) and Ow vs. Ob ($p < 0.01$) children. Gender differences (Table 14) were also significant for all the dependent variables ($p < 0.001$).

PAQ-C-It construct validity (Table 15) has been assessed in normal weight, overweight, and obese samples highlighting significant correlation with PPAS ($r_{Nw} = 0.290$, $p < 0.001$; $r_{Ow} = 0.335$, $p < 0.001$; $r_{Ob} = 0.381$, $p < 0.001$) and PACES ($r_{Nw} = 0.227$, $p < 0.001$; $r_{Ow} = 0.318$, $p < 0.001$; $r_{Ob} = 0.213$, $p < 0.001$).

5 Discussion

The results from the present study reveal a two-factors model for PAQ-C-It, that is "school physical activity" and "outside school physical activity," as confirmed by other validation studies (Moore et al., 2007; Thomas and Upton, 2014; Gobbi et al., 2016; Voss et al., 2017; Erdim et al., 2019; Sirajudeen et al., 2022). The analysis showed good model fit, with all indices in the expected direction.

Similar to other studies, items asking about the frequency of participation in specific activities (PAQ2) contributed less to explain the total variance and total PAQ-C-It score (Sirajudeen et al., 2022; Cuberek et al., 2021), and it is probably associated with difficulties in

TABLE 8 Model Fit.

Model fit									
	χ^2	df	*p*	CFI	TLI	NFI	RMSEA	SRMSR	GFI
PAQ-C-It	149.579	26	<0.001	0.958	0.942	0.950	0.072	0.035	0.996
PPAS	185.524	34	<0.001	0.957	0.943	0.948	0.070	0.038	0.996
PACES	460.887	103	<0.001	0.914	0.900	0.892	0.062	0.045	0.996

CFI, comparative fit index; TLI, Tucker–Lewis index; NFI, Bentler–Bonett normed fit index; RMSEA, root mean square error of approximation; SRMSR, standardized root mean square residual; GFI = goodness of fit index.

TABLE 9 Construct validity assessment.

Correlation matrix		
	PPAS	PACES
PAQ-C-It	0.327**	0.258**
PPAS		0.351**

** = $p < 0.01$.

TABLE 10 Study 3 sample's characteristics.

	Descriptive statistics											
	Nw				Ow				Ob			
	Male		Female		Male		Female		Male		Female	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Height	1.54	0.10	1.54	0.08	1.57	0.09	1.56	0.08	1.58	0.09	1.56	0.08
Weight	43.89	9.08	44.46	8.27	57.27	8.37	57.64	7.35	74.44	11.04	71.96	12.91
BMI	18.38	2.07	18.57	2.19	23.16	1.47	23.47	1.58	29.35	3.44	29.64	3.91
PPAS	41.90	6.15	38.68	5.92	39.31	5.92	37.35	6.15	36.84	7.44	34.44	5.81
PAQ-C-It	2.70	0.69	2.3715	0.58	2.58	0.74	2.27	0.57	2.45	0.69	2.08	0.63
PACES	71.74	7.60	69.33	8.08	70.54	8.26	68.93	7.72	69.37	8.47	64.31	7.641

Nw, normal weight; Ow, overweight; Ob, obese.

TABLE 11 Model fit according to BMI cutoff.

Model fit											
Group		χ2	df	p	CFI	TLI	NFI	RMSEA	SRMSR	GFI	Cronbach α
Normal weight	PAQ-C-It	128.346	26	<0.001	0.945	0.923	0.932	0.072	0.039	0.995	0.821
	PPAS	132.185	34	<0.001	0.958	0.944	0.944	0.071	0.039	0.995	0.837
	PACES	391.887	103	<0.001	0.927	0.910	0.866	0.069	0.050	0.995	0.849
Overweight	PAQ-C-It	61.456	26	<0.001	0.954	0.937	0.924	0.076	0.041	0.993	0.832
	PPAS	94.909	34	<0.001	0.923	0.898	0.886	0.077	0.061	0.992	0.810
	PACES	280.902	103	<0.001	0.928	0.900	0.857	0.076	0.068	0.991	0.838
Obese	PAQ-C-It	38.425	26	<0.05	0.965	0.951	0.901	0.070	0.053	0.989	0.839
	PPAS	43.927	34	<0.05	0.972	0.963	0.889	0.055	0.048	0.990	0.863
	PACES	205.627	103	<0.001	0.925	0.905	0.896	0.071	0.066	0.982	0.841

estimating short bursts of PA, and different kinds of activities performed in specific-context populations.

These findings also suggest the need to adapt the PA checklist according to the activities that can be effectively carried out by children in different countries or areas.

Moreover, in contrast with our results, several studies also report satisfactory reliability for a single construct, presumably referred to MVPA during the last 7 days (Wang et al., 2016; Cuberek et al., 2021; Makai et al., 2023). As pointed out above, this may be due to the different movement habits worldwide, probably linked to the different organizations of the school system, which makes it more difficult to distinguish clearly between school and extra-school PA. The results of this study are consistent with those of another Italian study (Gobbi et al., 2016), reinforcing the hypothesis that the single or double

TABLE 12 Multivariate test.

Multivariate tests							
Effect		Value	*F*	Hypothesis df	Error df	Sig.	η_p^2
Gender	Wilks' lambda	0.946	17.376	3.000	905.000	0.000	0.054
BMI cutoff	Wilks' lambda	0.937	10.059	6.000	1810.000	0.000	0.032
Gender * BMI cutoff	Wilks' lambda	0.994	0.909	6.000	1810.000	0.487	0.003

TABLE 13 Pairwise comparison according to BMI cutoff.

Pairwise comparison between Nw-Ow-Ob sample										
		PAQ-C-It			PPAS			PACES		
		Mean diff.	SE	*p*	Mean diff.	SE	*p*	Mean diff.	SE	*p*
Nw	Ow	0.111	0.052	0.082	1.955	0.487	<0.001	0.791	0.621	0.410
	Ob	0.218	0.073	0.009	4.316	0.687	<0.001	3.011	0.875	0.002
Ow	Ob	0.106	0.081	0.387	2.361	0.757	0.005	2.221	0.965	0.056

Nw, normal weight; Ow, overweight; Ob, obese.

TABLE 14 Independent samples *t*-test according to gender.

Independent samples test (female vs. male)							
	t	df	Sig	Mean difference	Std. error difference	95% CI of the difference	
						Lower	Upper
PPAS	−6.216	599	0.000	−2.599	0.418	−3.420	−1.779
PAQ-C-It	−7.342	599	0.000	−0.31905	0.043	−0.404	−0.233
PACES	−4.363	599	0.000	−2.306	0.528	−3.343	−1.268

TABLE 15 Construct validity according to BMI cutoff.

Correlations			
		PAQ-C-IT	PACES
Normal weight	PPAS	0.290**	0.325**
	PAQ-C-IT	/	0.227**
Overweight	PPAS	0.335**	0.326**
	PAQ-C-IT	/	0.318**
Obese	PPAS	0.381**	0.416**
	PAQ-C-IT	/	0.213*

** = $p < 0.01$.

structure of the questionnaire could depend on the country system. Moreover, Wang et al. (2016) found that recreation and lunch factors did not add a significant contribution to model adaptation, while Sirajudeen et al. (2022) highlighted the important role of weather conditions (Canada vs. Kingdom of Saudi Arabia) in determining single- or double-factor structure.

Moreover, Sallis et al. (2016) highlighted the environmental factors that can best improve significantly adherence to PA in urban environments, such as net residential density, intersection density, public transport density, and number of parks, which should be considered and which could change results.

However, study 1 results were quite similar to study 2. In fact, the factor loading for both PAQ-C-It factors 1 and 2 was above the recommended value of 0.30, except for PAQ-C-It1. This could be related to different types of physical activity. In fact, the PAQ-C-It has been structured and validated in Canada, where the school, environmental, and social contexts allow to carry out a whole series of activities (such as canoeing, playing hockey, and skiing) that, conversely, in Italy are not popular or can be practiced only in specific environments. Some studies, in fact, modified the activities reported in the checklist (Makai et al., 2023; Isa et al., 2019; Cuberek et al., 2021; Gobbi et al., 2016). The cultural adaptation modified or removed the uncommon activities and replaced them with other fitting better country context: Wang et al. (2016) and Makai et al. (2023) removed cross-country skiing and ice hockey/ringette street. Gobbi et al. (2016) changed inline skating with roller skating, football with rugby, street hockey with hockey, floor hockey with tennis, cross-country skiing with karate/martial arts, and ice hockey with ringette, while Cuberek et al. (2021) removed rowing/canoeing and added combat sports, gymnastics, handball/dodgeball, horse riding, parkour/street workout, and fitness/yoga to better fit each contexts.

Probably, differences in checklist and different language and country adaptations could lead to the determination of a single- or two-factor model. The exploratory factor analysis for PPAS and PACES showed, in both questionnaires, a two-factor structure (positive negative scale, respectively) both with a goodness-of-fit model. Moreover, the analysis of the construct validity highlighted a positive meaningful relationship between the levels of physical activity, self-efficacy, and enjoyment.

To the best our knowledge, this is the first study to assess internal consistency, validity, and reliability of PAQ-C-It in normal weight, overweight, and obese children. Cronbach α for PPAS and PACES were in line with the coefficient obtained by Bortoli and Robazza (1997) and Carraro et al. (2008). In addition to goodness of model fit, the results of the three studies showed a significant effect for gender and BMI cutoff. Higher levels of physical activity, self-efficacy, and enjoyment were reported in boys than girls, and in children with normal weight compared to the those overweight or obese. The results of the present study suggest that (1) PAQ-C-It represents a valid tool—showing goodness of model fit, validity, and reliability—to assess PA in overweight and obese children, (2) self-efficacy and enjoyment are both predictors of high PA in both normal weight, overweight, and obese children, and (3) self-efficacy is positively related to enjoyment and this association is stronger in obese children than normal weight and obese ones.

The recent findings highlight that school-based interventions can be effective in increasing physical activity and enjoyment in children and adolescents (Burns et al., 2017; Papadopoulos et al., 2022). Moreover, coaches and teachers proposing enjoyable and task-involving environments can better promote self-efficacy and motivation in children and adolescents (Amaro et al., 2023). The findings in school setting also reveal the key role assumed by the teacher and peers in influencing students' adherence to physical education (Vasconcellos et al., 2020; Monacis et al., 2022b). In fact, according to White et al. (2022), the motivation and the lack of motor competence learning in physical education is linked to the teacher's behavior oriented to performance, while the establishment of a positive peer relationship can better promote satisfaction and positive feelings.

Therefore, the results of the present study, in addition to confirming the results of the study of Gobbi et al. (2016)—conducted even on children with simple forms of congenital heart defects—contributes to providing the first validation of the PAQ-C-It questionnaire in both overweight and obese children, adding some knowledge about PAQ-C-It instrument and opening new research fields to ensure and maintain active lifestyles during lifetime and developmental age.

6 Limitations and conclusion

This study provides good validity and reliability of PAQ-C-It in normal weight, overweight, and obese children, proposing significant implications for future scientific research and interventions aimed at the promotion of healthy habits in the developmental age. Despite positive results, the study presents some limitations and future research directions. In this research, the Cole et al. (2000) study has been used to classify children as normal weight, overweight, or obese. Future research should investigate the same construct using different tools to assess body composition (i.e., bioelectric impedance analysis, dual-energy x-ray absorptiometry, circumferences, and body folds, and BMI Z-scores). Moreover, the present study involves only children aged 11–13 years, while PAQ-C-It has been validated in the fourth and fifth grade children, and children with congenital heart defects aged 8–14 years. Future studies should investigate the effect of age and the most common type of PA (covariate) on the same variables and the possible impact of the different school systems, organizations, contexts, and countries on the one- or two-factor structure of the questionnaire. Moreover, investigations about construct validity between levels of physical activity, self-efficacy, and enjoyment can be useful to carry out potential theoretical framework for PE teachers promoting motives for physical activity in different contexts (physical education, fitness, and adapted physical activity). It could also be important to define the mediating role of self-efficacy and enjoyment in determining higher levels of PA and developing specific methodologies for PE teachers that could facilitate and extend better comprehension and adherence to physical activity in children.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

DM: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Writing – original draft. SA: Data curation, Investigation, Writing – original draft. DC: Methodology, Supervision, Writing – review & editing, Project administration. PL: Supervision, Validation, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Amaro, N., Monteiro, D., Rodrigues, F., Matos, R., Jacinto, M., Cavaco, B., et al. (2023). Task-involving motivational climate and enjoyment in youth male football athletes: the mediation role of self-determined motivation. *Int. J. Environ. Res. Public Health* 20:3044. doi: 10.3390/ijerph20043044

Barker, A. R., Gracia-Marco, L., Ruiz, J. R., Castillo, M. J., Aparicio-Ugarriza, R., González-Gross, M., et al. (2018). Physical activity, sedentary time, TV viewing, physical fitness and cardiovascular disease risk in adolescents: the HELENA study. *Int. J. Cardiol.* 254, 303–309. doi: 10.1016/j.ijcard.2017.11.080

Barry, M. J., Nicholson, W. K., Cabana, M., Coker, T. R., Davidson, K. W., Davis, E. M., et al. (2022). Behavioral counseling interventions to promote a healthy diet and physical activity for cardiovascular disease prevention in adults without cardiovascular disease risk factors: US preventive services task force recommendation statement. *JAMA* 328, 367–374. doi: 10.1001/jama.2022.10951

Bevan, N., O'Brien, K. S., Lin, C.-Y., Latner, J. D., Vandenberg, B., Jeanes, R., et al. (2021). The relationship between weight stigma, physical appearance concerns, and enjoyment and tendency to avoid physical activity and sport. *Int. J. Environ. Res. Public Health* 18:9957. doi: 10.3390/ijerph18199957

Biino, V., Tinagli, V., Borioni, F., and Pesce, C. (2023). Cognitively enriched physical activity may foster motor competence and executive function as early as preschool age: a pilot trial. *Phys. Educ. Sport Pedagogy* 28, 425–443. doi: 10.1080/17408989.2021.1990249

Blair, S. N. (2009). Physical inactivity: the biggest public health problem of the 21st century. *Br. J. Sports Med.* 43, 1–2

Bortoli, L., and Robazza, C. (1997). Italian version of the perceived physical ability scale. *Percept. Mot. Skills* 85, 187–192. doi: 10.2466/pms.1997.85.1.187

Bourdier, P., Simon, C., Bessesen, D. H., Blanc, S., and Bergouignan, A. (2023). The role of physical activity in the regulation of body weight: the overlooked contribution of light physical activity and sedentary behaviors. *Obes. Rev.* 24:e13528. doi: 10.1111/obr.13528

Bull, F. C., Al-Ansari, S. S., Biddle, S., Borodulin, K., Buman, M. P., Cardon, G., et al. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behavior. *Br. J. Sports Med.* 54:1451. doi: 10.1136/bjsports-2020-102955

Burns, R. D., Fu, Y., and Podlog, L. W. (2017). School-based physical activity interventions and physical activity enjoyment: a meta-analysis. *Prev. Med.* 103, 84–90. doi: 10.1016/j.ypmed.2017.08.011

Caputo, E. L., and Reichert, F. F. (2020). Studies of physical activity and COVID-19 during the pandemic: a scoping review. *J. Phys. Act. Health* 17, 1275–1284. doi: 10.1123/jpah.2020-0406

Carraro, A., Young, M., and Robazza, C. (2008). A contribution to the validation of the physical activity enjoyment scale in an Italian sample. *Soc. Behav. Personal. Int. J.* 36, 911–918. doi: 10.2224/sbp.2008.36.7.911

Chen, J., Bai, Y., and Ni, W. (2023). Reasons and promote strategies of physical activity constraints in obese/overweight children and adolescents. *Sports Med. Health Sci.* 6, 25–36. doi: 10.1016/j.smhs.2023.10.004

Cole, T. J., Bellizzi, M. C., Flegal, K. M., and Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 320, 1240–1243. doi: 10.1136/bmj.320.7244.1240

Crocker, P. R., Bailey, D. A., Faulkner, R. A., Kowalski, K. C., and McGrath, R. (1997). Measuring general levels of physical activity: preliminary evidence for the Physical Activity Questionnaire for Older Children. *Med. Sci. Sports Exerc.* 29, 1344–1349. doi: 10.1097/00005768-199710000-00011

Crocker, P. R., Eklund, R. C., and Kowalski, K. C. (2000). Children's physical activity and physical self-perceptions. *J. Sports Sci.* 18, 383–394. doi: 10.1080/02640410050074313

Cuberek, R., Janíková, M., and Dygrýn, J. (2021). Adaptation and validation of the Physical Activity Questionnaire for Older Children (PAQ-C) among Czech children. *PLoS One* 16:e0245256. doi: 10.1371/journal.pone.0245256

Di Liegro, C. M., Schiera, G., Proia, P., and Di Liegro, I. (2019). Physical activity and brain health. *Genes* 10, 10:720. doi: 10.3390/genes10090720

Erdim, L., Ergün, A., and Kuğuoğlu, S. (2019). Reliability and validity of the Turkish version of the Physical Activity Questionnaire for Older Children (PAQ-C). *Turk. J. Med. Sci.* 49, 162–169. doi: 10.3906/sag-1806-212

Gobbi, E., Elliot, C., Varnier, M., and Carraro, A. (2016). Psychometric properties of the Physical Activity Questionnaire for Older Children in Italy: testing the validity among a general and clinical pediatric population. *PLoS One* 11:e0156354. doi: 10.1371/journal.pone.0156354

Greule, C., Sudeck, G., Thiel, A., Kastner, L., Janßen, P., Nieß, A., et al. (2024). Correlates of physical activity enjoyment in children and adolescents for a new perspective on the treatment of overweight: a systematic literature review. *Obes. Rev.* 25:e13655. doi: 10.1111/obr.13655

Guthold, R., Stevens, G. A., Riley, L. M., and Bull, F. C. (2020). Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. *Lancet Child Adolesc. Health* 4, 23–35. doi: 10.1016/S2352-4642(19)30323-2

Heemskerk, C., Strand, S., and Malmberg, L.-E. (2023). Physical activity predicts task-related behavior, affect and tiredness in the primary school classroom: a within-person experiment. *Br. J. Educ. Psychol.* 93, 130–151. doi: 10.1111/bjep.12523

Henning, L., Dreiskämper, D., Pauly, H., Filz, S., and Tietjens, M. (2022). What influences Children's physical activity? Investigating the effects of physical self-concept, physical self-guides, self-efficacy, and motivation. *J. Sport Exerc. Psychol.* 44, 393–408. doi: 10.1123/jsep.2021-0270

Hillman, C. H., Logan, N. E., and Shigeta, T. T. (2019). A review of acute physical activity effects on brain and cognition in children. *Transl. J. Am. Coll. Sports Med.* 4, 132–136. doi: 10.1249/TJX.0000000000000101

Hulteen, R. M., Morgan, P. J., Barnett, L. M., Stodden, D. F., and Lubans, D. R. (2018). Development of foundational movement skills: a conceptual model for physical activity across the lifespan. *Sports Med.* 48:1533:1540. doi: 10.1007/s40279-018-0892-6

Ingram, J., Maciejewski, G., and Hand, C. J. (2020). Changes in diet, sleep, and physical activity are associated with differences in negative mood during COVID-19 lockdown. *Front. Psychol.* 11:588604. doi: 10.3389/fpsyg.2020.588604

Isa, T., Sawa, R., Torizawa, K., Murata, S., Saito, T., Ebina, A., et al. (2019). Reliability and validity of the Japanese version of the Physical Activity Questionnaire for Older Children. *Clin. Med. Insights Pediatr.* 13:1179556519835833. doi: 10.1177/1179556519835833

Julian, V., Bergsten, P., Forslund, A., Ahlstrom, H., Ciba, I., Dahlbom, M., et al. (2022). Sedentary time has a stronger impact on metabolic health than moderate to vigorous physical activity in adolescents with obesity: a cross-sectional analysis of the Beta-JUDO study. *Pediatr. Obes.* 17:e12897. doi: 10.1111/ijpo.12897

Katzmarzyk, P. T. (2023). Expanding our understanding of the global impact of physical inactivity. *Lancet Glob. Health* 11, e2–e3. doi: 10.1016/S2214-109X(22)00482-X

Kelso, A., Linder, S., Reimers, A. K., Klug, S. J., Alesi, M., Scifo, L., et al. (2020). Effects of school-based interventions on motivation towards physical activity in children and adolescents: a systematic review and meta-analysis. *Psychol. Sport Exerc.* 51:101770. doi: 10.1016/j.psychsport.2020.101770

Klos, L., Feil, K., Eberhardt, T., and Jekauc, D. (2020). Interventions to promote positive affect and physical activity in children, adolescents and young adults—a systematic review. *Sports* 8:26. doi: 10.3390/sports8020026

Kohl, H. W., Fulton, J. E., and Caspersen, C. J. (2000). Assessment of physical activity among children and adolescents: a review and synthesis. *Prev. Med.* 31, S54–S76. doi: 10.1006/pmed.1999.0542

Kowalski, K. C., Crocker, P. R. E., and Donen, R. M. (2004). The Physical Activity Questionnaire for Older Children (PAQ-C) and adolescents (PAQ-A) manual. Saskatoon, SK: College of Kinesiology, University of Saskatchewan, 1–38.

Kowalski, K. C., Crocker, P. R. E., and Faulkner, R. A. (1997). Validation of the Physical Activity Questionnaire for Older Children. *Pediatr. Exerc. Sci.* 9, 174–186. doi: 10.1123/pes.9.2.174

Makai, A., Prémusz, V., Dózsa-Juhász, O., Fodor-Mazzag, K., Melczer, C., and Ács, P. (2023). Examination of physical activity patterns of children, reliability and structural validity testing of the Hungarian version of the PAQ-C questionnaire. *Children* 10:1547. doi: 10.3390/children10091547

Malm, C., Jakobsson, J., and Isaksson, A. (2019). Physical activity and sports—real health benefits: a review with insight into the public health of Sweden. *Sports* 7:127. doi: 10.3390/sports7050127

Mao, J. J., Pillai, G. G., Andrade, C. J., Ligibel, J. A., Basu, P., Cohen, L., et al. (2022). Integrative oncology: addressing the global challenges of cancer prevention and treatment. *CA Cancer J. Clin.* 72, 144–164. doi: 10.3322/caac.21706

Marasso, D., Lupo, C., Collura, S., Rainoldi, A., and Brustio, P. R. (2021). Subjective versus objective measure of physical activity: a systematic review and meta-analysis of the convergent validity of the physical activity questionnaire for children (PAQ-C). *Int. J. Environ. Res. Public Health* 18:3413. doi: 10.3390/ijerph18073413

Mohd Zaki, N. A., Sahril, N., Omar, M. A., Ahmad, M. H., Baharudin, A., and Mohd Nor, N. S. (2016). Reliability and validity of the Physical Activity Questionnaire for Older Children (PAQ-C) in Malay language. *International Journal of Public Health Research* 6, 670–676. Available at: https://spaj.ukm.my/ijphr/index.php/ijphr/article/view/16

Monacis, D., Colella, D., and Limone, P. (2022b). Non-linear didactic technology-based intervention to enhance basic motor competencies with MOBAK-5: a pilot study in primary school. *Phys. Act. Rev.* 10, 22–30. doi: 10.16926/PAR.2022.10.03

Monacis, D., Trecroci, A., Invernizzi, P. L., and Colella, D. (2022a). Can enjoyment and physical self-perception mediate the relationship between BMI and levels of physical activity? Preliminary results from the regional observatory of motor development in Italy. *Int. J. Environ. Res. Public Health* 19:12567. doi: 10.3390/ijerph191912567

Moore, J. B., Hanes, J. C., Barbeau, P., Gutin, B., Treviño, R. P., and Yin, Z. (2007). Validation of the Physical Activity Questionnaire for Older Children in children of different races. *Pediatr. Exerc. Sci.* 19, 6–19. doi: 10.1123/pes.19.1.6

Neil-Sztramko, S. E., Caldwell, H., and Dobbins, M. (2021). School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database Syst. Rev.* 2021:CD007651. doi: 10.1002/14651858.CD007651.pub3

Papadopoulos, N., Mantilla, A., Bussey, K., Emonson, C., Olive, L., McGillivray, J., et al. (2022). Understanding the benefits of brief classroom-based physical activity interventions on primary school-aged children's enjoyment and subjective wellbeing: a systematic review. *J. Sch. Health* 92, 916–932. doi: 10.1111/josh.13196

Puccinelli, P. J., da Costa, T. S., Seffrin, A., de Lira, C. A. B., Vancini, R. L., Nikolaidis, P. T., et al. (2021). Reduced level of physical activity during COVID-19 pandemic is associated with depression and anxiety levels: an internet-based survey. *BMC Public Health* 21:425. doi: 10.1186/s12889-021-10470-z

Robinson, E., Boyland, E., Chisholm, A., Harrold, J., Maloney, N. G., Marty, L., et al. (2021). Obesity, eating behavior and physical activity during COVID-19 lockdown: a study of UK adults. *Appetite* 156:104853. doi: 10.1016/j.appet.2020.104853

Ruiz-Montero, P. J., Chiva-Bartoll, O., Baena-Extremera, A., and Hortigüela-Alcalá, D. (2020). Gender, physical self-perception and overall physical fitness in secondary school students: a multiple mediation model. *Int. J. Environ. Res. Public Health* 17:6871. doi: 10.3390/ijerph17186871

Sallis, J. F., Cerin, E., Conway, T. L., Adams, M. A., Frank, L. D., Pratt, M., et al. (2016). Physical activity in relation to urban environments in 14 cities worldwide: a cross-sectional study. *Lancet* 387, 2207–2217. doi: 10.1016/S0140-6736(15)01284-2

Schmidt, M. D., Cleland, V. J., Thomson, R. J., Dwyer, T., and Venn, A. J. (2008). A comparison of subjective and objective measures of physical activity and fitness in identifying associations with cardiometabolic risk factors. *Ann. Epidemiol.* 18, 378–386. doi: 10.1016/j.annepidem.2008.01.005

Sedlačík, M., Lacinová, V., and Hasilová, K. (2023). Assessment of physical activity among adolescents: a guide to the literature. *Front. Psychol.* 14:1232382. doi: 10.3389/fpsyg.2023.1232382

Singh, B., Olds, T., Curtis, R., Dumuid, D., Virgara, R., Watson, A., et al. (2023). Effectiveness of physical activity interventions for improving depression, anxiety and distress: an overview of systematic reviews. *Br. J. Sports Med.* 57, 1203–1209. doi: 10.1136/bjsports-2022-106195

Singh, R., Pattisapu, A., and Emery, M. S. (2020). US physical activity guidelines: current state, impact and future directions. *Trends Cardiovasc. Med.* 30, 407–412. doi: 10.1016/j.tcm.2019.10.002

Sirajudeen, M. S., Waly, M., Manzar, M. D., Alqahtani, M., Alzhrani, M., Alanazi, A., et al. (2022). Physical Activity Questionnaire for Older Children (PAQ-C): Arabic translation, cross-cultural adaptation, and psychometric validation in school-aged children in Saudi Arabia. *PeerJ* 10:e13237. doi: 10.7717/peerj.13237

Sirard, J. R., and Pate, R. R. (2001). Physical activity assessment in children and adolescents. *Sports Med.* 31, 439–454. doi: 10.2165/00007256-200131060-00004

Thomas, E. L., and Upton, D. (2014). Psychometric properties of the Physical Activity Questionnaire for Older Children (PAQ-C) in the UK. *Psychol. Sport Exerc.* 15, 280–287. doi: 10.1016/j.psychsport.2014.02.002

Trecroci, A., Invernizzi, P. L., Monacis, D., and Colella, D. (2021). Actual and perceived motor competence in relation to body mass index in primary school-aged children: a systematic review. *Sustainability* 13:9994. doi: 10.3390/su13179994

Vasconcellos, D., Parker, P. D., Hilland, T., Cinelli, R., Owen, K. B., Kapsal, N., et al. (2020). Self-determination theory applied to physical education: a systematic review and meta-analysis. *J. Educ. Psychol.* 112, 1444–1469. doi: 10.1037/edu0000420

Voss, C., Dean, P. H., Gardner, R. F., Duncombe, S. L., and Harris, K. C. (2017). Validity and reliability of the physical activity questionnaire for children (PAQ-C) and adolescents (PAQ-A) in individuals with congenital heart disease. *PLoS One* 12:e0175806. doi: 10.1371/journal.pone.0175806

Wang, J. J., Baranowski, T., Lau, W. C. P., Chen, T. A., and Pitkethly, A. J. (2016). Validation of the Physical Activity Questionnaire for Older Children (PAQ-C) among Chinese children. *Biomed. Environ. Sci.* 29, 177–186. doi: 10.3967/bes2016.022

White, K., Lubans, D. R., and Eather, N. (2022). Feasibility and preliminary efficacy of a school-based health and well-being program for adolescent girls. *Pilot Feasibility Stud.* 8:15. doi: 10.1186/s40814-021-00964-3

World Health Organization. (2023). Overweight and obesity Available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. (Accessed September 13, 2023)

Zenic, N., Taiar, R., Gilic, B., Blazevic, M., Maric, D., Pojskic, H., et al. (2020). Levels and changes of physical activity in adolescents during the COVID-19 pandemic: contextualizing urban vs. rural living environment. *Appl. Sci.* 10:3997. doi: 10.3390/app10113997