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ORIGINAL

VALIDEZ CONVERGENTE DE DOS ÍTEMS PARA DIFERENCIAR ENTRE ESCOLARES ACTIVOS Y SEDENTARIOS

CONVERGENT VALIDITY OF TWO ITEMS TO DIFFERENTIATE BETWEEN ACTIVE AND SEDENTARY STUDENTS

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ABSTRACT

This study examined the validity and reliability of two physical activity Child Health and Illness Profile - Child Edition (CHIP-CE) items to differentiate between active and sedentary students. An observational cross-sectional study design was used with 1,073 students from 11 to 13 years old, from 20 schools in the province of Cuenca (Spain). Item 13 and item 28 of the CHIP-CE, a generic childhood quality of life instrument, were evaluated. Convergent validity was examined using adiposity, lipidic, metabolic, blood pressure and cardiorespiratory fitness variables as criteria.

The Spearman coefficient of correlation between the two items was 0.60. The Spearman correlation coefficients between the physical activity items and the anthropometric, lipidic, metabolic, blood pressure and cardiorespiratory fitness variables showed higher values with percentage body fat, fasting insulin, recovery heart rate and cardiorespiratory fitness.

Our two-item questionnaire exhibited acceptable validity and high internal consistency for classifying students as either active or sedentary.

KEY WORDS: Validity, physical activity, quality of life, schoolchildren.

RESUMEN

Este estudio examina la validez y fiabilidad de dos ítems de actividad física (AF) incluidos en el CHIP-CE para discriminar entre escolares activos y sedentarios.

Se realizó un estudio observacional-transversal, con 1073 escolares de ambos sexos, de 11-13 años. Mediante los ítems 13 y 28 del CHIP-CE se clasificó a los escolares como activos o sedentarios. La validez convergente fue examinada utilizando como criterio variables de adiposidad, lipídicas, metabólicas, de presión arterial y de fitness.

El coeficiente de correlación de Spearman entre los dos ítems fue de 0,60. Los coeficientes de correlación de Spearman entre la media de los dos items de AF y las variables de salud mostraron valores más altos con el porcentaje de grasa corporal, la insulina basal, la frecuencia cardiaca de recuperación y el fitness.

La escala de dos ítems extraída del CHIP-CE es un instrumento válido para clasificar a los escolares en activos o sedentarios.

PALABRAS CLAVES: Validez, actividad física, calidad de vida, escolares.

INTRODUCTION

Regular physical activity has been associated with numerous benefits for the physical, mental and social health of children and adults. Active children have lower risk of cardiovascular disease,[1] greater bone mineral density,[2] more self-esteem[3] and a lower prevalence of depression[4] than sedentary children. People who are physically active in childhood tend to continue to be active in adult life.[5] Children must have a minimum of 60 minutes of moderate-to-high intensity physical activity every day or almost every day to be considered active.[6]

The sporadic and unsystematic nature of physical activity and its short duration in children and adolescents make it difficult to quantify in this group. Indirect calorimetry, double-labelled water and accelerometers are some of the techniques that have been used to quantify physical activity objectively.[7,8] These techniques are difficult to use in large population samples while physical activity questionnaires for children can be administered to large samples quickly and inexpensively. Children, however, usually have difficulties remembering their past activities; they have a subjective perception of time and less cognitive ability to interpret questions.[9]

Most questionnaires for measuring physical activity in children and adolescents have low-to-moderate validity and acceptable test-retest reliability.[7,9,10] Many have a large number of items, which become complicated to administer to large groups. Only a two-item questionnaire has been designed to differentiate between active and sedentary children,[11] where active children are defined as having moderate-to-high intensity physical activity at least three times a week,[12] which is a criterion that differs from recommendations by various international institutions.[6,13]

This study was undertaken to assess the validity and reliability of two physical activity items of the Child Health and Illness Profile - Child Edition (CHIP-CE) questionnaire to discriminate between active and sedentary students aged 11 to 13 years.

MATERIAL AND METHODS

Study design and subjects

An observational, cross-sectional study was conducted with 1,073 schoolchildren of both sexes, 11 to 13 years old, from 20 schools in the province of Cuenca (Spain). We used measurements from a cluster-randomised clinical trial to evaluate the effectiveness of physical activity in preventing obesity in schoolchildren.[14] Meetings were held with the parents in each school after the school council authorised the study. The study objectives and procedures were described at the meeting. The parents or tutors of each child were contacted later by letter to request written consent. Study personnel visited each classroom to explain to students the importance and objectives of the study and to request their collaboration. The study was approved by the Clinical Research Ethics Committee of the *Hospital Virgen de la Luz* of Cuenca.

Questionnaire items

The validity of two items was evaluated: item 13, "In the past 4 weeks, how often did you play active games or sports?" and item 28, "In the past 4 weeks, how often did you run hard to play or do sports?" These items pertain to the CHIP-CE (*Child Health and Illness Profile - Child Edition,* which is a generic childhood quality-of-life instrument validated in Spanish[15] that consists of 45 items distributed in 5 health dimensions. It is scored by a Likert-type (1-5 range) summation scale with 5 response options ("Never," "Very few days," "Some days," "Almost every day," and "Every day"). Options were represented by pictograms and figures in the questionnaire to make it more comprehensible to children (see http://www.uclm.es/centro/cess/movi/chipce.html). A higher score on items 13 and 28 indicated more frequent and intense physical activity. The CHIP-CE was administered to groups of children who were previously given an explanation of how to complete it in the classroom during the school day by the same investigator, and after blood collection and anthropometric measurements.

Anthropometric variables, blood pressure, lipid metabolism profile and cardiorespiratory fitness

- *Weight and height*: given as the mean of two determinations in standardised conditions.

- *Body mass index (BMI)*: calculated by dividing weight, in kilograms, by the square of the height in meters. Schoolchildren were classified as normal weight, overweight and obese according to the cutoff points proposed by Cole et al.[16]

- *Tricipital skinfold thickness (TST)*: given as the mean of three measurements using a Holtain skinfold caliper, with a precision of 0.1 mm.

- *Percentage body fat (%BF)*: estimated by electrical bioimpedance (%BF) using eight contact electrodes (Tanita Corp. Model BC-418 MA; Tokyo, Japan).[17]

- *Waist circumference*: given as the mean of three measurements made at the midpoint between the last rib and the iliac crest.

- *Systolic blood pressure (SBP) and diastolic blood pressure (DBP):* given as the mean of three systolic blood pressure (SBP) and diastolic blood pressure (DBP) determinations made over a five-minute interval. The child rested for at least five minutes before the first determination, seated in a quiet and calm room, with the right arm flexed to bring the cuff to the height of the heart. Blood pressure was determined with an OMRON M5-I automatic sphygmomanometer.[18]

- *Lipid-metabolic profile*: after a fast of at least 12 hours, blood samples were drawn from the cubital vein. The following were determined: total cholesterol, triglycerides, apolipoprotein B, apolipoprotein A-I and the insulin resistance index used the homeostasis model assessment of insulin resistance (HOMA).[19]

- *Cardiorespiratory fitness*: evaluated using the Ruffier-Dickson test,[20] which measures cardiac resistance based on the evolution of heart rate at rest and at the end of exercise. The exercise consisted of 30 leg flexions and extensions in 45" at a rate marked by an audible signal. Heart rate was taken after a 5-minute rest while sitting down (P1), immediately after the exercise ended (P2) and after 1 minute of recovery while sitting down (P3). The score was calculated using the following formula: (P2-70) + 2(P3-P1)/10. Lower test scores indicated better cardiorespiratory adaptation to effort and, consequently, better fitness.

Statistical analysis

Data were verified after independent double data entry. A descriptive analysis was made of the sample characteristics, and the means were compared with the Student t-test of two independent groups.

The mean of the scores for items 13 and 28 of the CHIP-CE was calculated and children were categorised as sedentary (mean score < 4.5) or active (mean score ≥ 4.5) according to Center for Disease Control (CDC) recommendations,[6] which propose that children and adolescents have at least 60 minutes of moderate-to-high intensity physical activity most days of the week, preferably every day.

The floor and ceiling effects of each item were evaluated by calculating the proportion of cases with minimum and maximum values, respectively.

Analysis of reliability. Item scores were correlated with the Spearman correlation coefficient.

Convergent validity. The Spearman correlation coefficients between the scores of the two items and the mean scores of the anthropometric, lipidic, metabolic, blood pressure and cardiorespiratory fitness variables were used to evaluate the convergent validity of the questionnaire. An analysis of covariance (ANCOVA) model was used to estimate the differences in the mean scores of each of the above variables between active and sedentary students, adjusted for age.

All analyses were made for the overall sample, by sex, and by active or sedentary status. Analyses were done with SPSS - Windows 19.0 software.

RESULTS

Of 1,409 students invited to participate in the study, 1,073 (76.15%) accepted, 536 of whom were boys (49.9%). The mean age of boys (11.08 years; SD = 0.78 years) and girls (10.95 years; SD = 0.73 years) did not differ significantly. The prevalence of overweight/obesity and average values of the anthropometric variables, lipid metabolism profile, blood pressure and cardiorespiratory fitness of the participating students, by sex, are shown in Table 1.

The Spearman coefficient of correlation between the two items was 0.60. The ceiling and floor effect of item 13 were 41.3% and 0.8%, respectively, and for item 28 were 41.1% and 0.8%, respectively.

Convergent validity

The Spearman coefficients of correlation between the anthropometric, lipidic, metabolic, blood pressure and cardiorespiratory fitness variables and the frequency and intensity of physical activity as measured with item 13, item 28 and the mean score of the sum of items 13 and 28, adjusted for sex, are summarised in Table 2. All correlations, except apolipoprotein B and total cholesterol, were significant. The highest Spearman correlation coefficients were with % BF ($r = -0.25$, $p < 0.001$), fasting insulin ($r = -0.23$, $p < 0.001$), the HOMA index ($r = -0.23$, $p < 0.001$), recovery heart rate ($r = -0.28$, $p < 0.001$) and cardiorespiratory fitness ($r = -0.23$, $p < 0.001$). The correlation coefficients generally showed higher values in boys than in girls.

The mean values of the anthropometric, lipidic, metabolic, blood pressure and cardiorespiratory fitness variables were significantly lower in active than in sedentary students, with the exception of SBP, which had higher mean values in active student. No significant differences were found in apolipoprotein B and total cholesterol (Table 3). Active children of both sexes obtained similar results when adjusted for sex. However, active girls had significantly better scores than sedentary girls in BMI, TST, % BF, waist circumference,and DBP.

Table 1. Measures of adiposity, lipid metabolism profile, blood pressure and cardiorespiratory fitness of the study participants.

	Total n = 1073 Mean (SD)	**Boys** n = 536 Mean (SD)	**Girls** n = 537 Mean (SD)	*p*
% overweight/obesity†	27.4	28.2	26.5	0.57
BMI (kg/m^2)	19.36 (3.60)	19.37 (3.58)	19.35 (3.61)	0.908
TST (mm)	16.42 (6.98)	15.81 (7.36)	17.02 (6.53)	0.004
% BF	23.86 (6.58)	22.20 (6.84)	25.51 (5.86)	0.001
Waist circumference (cm)	71.90 (10.03)	72.43 (10.56)	71.38 (9.45)	0.086
Apolipoprotein A-I (mg/dl)	149.46 (20.58)	152.18 (21.11)	146.73 (19.68)	0.001
Apolipoprotein B (mg/dl)	62.79 (13.70)	62.79 (14.04)	62.80 (13.37)	0.989
Total cholesterol (mg/dl)	159.28 (24.21)	160.29 (24.54)	158.26 (23.86)	0.171
Triglycerides (mg/dl)	65.97 (31.37)	62.13 (32.65)	69.82 (29.55)	0.001
Fasting insulin (mclU/ml)	7.23 (4.91)	6.15 (4.01)	8.32 (5.47)	0.001
HOMA	1.52 (1.08)	1.31 (0.87)	1.74 (1.22)	0.001
SBP (mmHg)	105.67 (9.03)	106.33 (9.20)	105.01 (8.81)	0.017
DBP (mmHg)	63.74 (6.60)	63.11 (6.91)	64.36 (6.21)	0.002
HR at rest (beats/min)	87.61 (10.77)	85.06 (9.85)	90.22 (11.08)	0.001
HR after exercise (beats/min)	149.82 (13.94)	147.51 (12.44)	152.01(14.90)	0.001
HR after 1' recovery (beats/min)	97.63 (16.80)	90.53 (14.91)	104.96 (15.53)	0.001
Cardiorespiratory fitness ‡	9.98 (3.23)	8.84 (2.85)	11.14 (3.19)	0.001

† According to the cut-off points proponed by the International Obesity Task Force

‡ Measured with the Ruffier-Dickson test

BMI = body mass index; TST = tricipital skinfold thickness; % BF = percentage body fat measured by bioimpedance; SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate.

Table 2. Correlation coefficients between adiposity, lipid metabolism profile, blood pressure and cardiorespiratory fitness and the frequency and intensity of physical activity measured with item 13, item 28 and

	Boys n = 536			**Girls** n = 537			**Total** n = 1073		
	Item 13	Item 28	Mean of items 13 + 28	Item 13	Item 28	Mean of items 13 + 28	Item 13	Item 28	Mean of items 13 + 28
BMI (kg/m^2)	-0.144**	-0.114**	-0.156**	-0.091*	-0.097*	-0.100*	-0.116**	-0.094**	-0.114**
TST (mm)	-0.196**	-0.186**	-0.219**	-0.088*	-0.070	-0.081	-0.176**	-0.162**	-0.183**
% BF	-0.197**	-0.172**	-0.211**	-0.100*	-0.122**	-0.115**	-0.224**	-0.237**	-0.250**
Waist circumference (cm)	-0.164**	-0.133**	-0.82**	-0.094*	-0.087*	-0.097*	-0.118**	-0.088**	-0.115**
Apolipoprotein A-I (mg/dl)	0.106*	0.081	0.117**	0.091*	0.076	0.088*	0.127**	0.120**	0.138**
Apolipoprotein B (mg/dl)	-0.049	-0.092*	-0.077	0.015	-0.009	0.010	-0.016	-0.040	-0.027
Total cholesterol (mg/dl)	-0.007	-0.059	-0.030	0.014	-0.024	-0.002	-0.016	-0.012	0.006
Triglycerides (mg/dl)	-0.159**	-0.128**	-0.165**	-0.069	-0.073	-0.070	-0.160**	-0.158**	-0.170**
Fasting insulin (mclU/ml)	-0.184**	-0.155**	-0.206**	-0.101*	-0.094*	-0.108*	-0.203**	-0.205**	-0.229**
HOMA	-0.187**	-0.151**	-0.206**	-0.119**	-0.106*	-0.126**	-0.206**	-0.201**	-0.228**
SBP (mmHg)	0.071	0.092*	0.086	-0.045	0.026	-0.006	0.031	0.078*	0.062*
DBP (mmHg)	-0.002	-0.014	-0.006	-0.086*	-0.036	-0.059	-0.079*	-0.061*	-0.072*
HR at rest (beats/min)	-0.036	-0.078	-0.071	-0.095	0.005	-0.044	-0.143**	-0.119**	-0.144**
HR after exercise (beats/min)	-0.176**	-0.152**	-0.208**	-0.059	0.089	0.026	-0.170**	-0.084*	-0.144**
HR after 1' recovery (beats/min)	-0.143*	-0.169**	-0.184**	-0.113	0.013	-0.048	-0.274**	-0.228**	-0.278**
Cardiorespiratory fitness [†]	-0.203**	-0.157**	-0.215**	-0.063	0.059	0.006	-0.247**	-0.167**	-0.230**

$^{*}p<0.05$; $^{**}p<0.01$.

[†] Measured with the Ruffier-Dickson test

BMI = body mass index; TST= tricipital skinfold thickness; % BF = percentage body fat measured by bioimped

SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate.

the mean of item 13 + 28, by

Table 3. Differences between active and sedentary schoolchildren in the mean scores of adiposity, lipid metabolism profile, blood pressure and cardiorespiratory fitness by sex and adjusted for age.

	Boys			**Girls**			**Total**		
	Active Mean (SD) n = 313	Sedentary Mean (SD) n = 200	p	Active Mean (SD) n = 166	Sedentary Mean (SD) n = 355	p	Active Mean (SD) n = 480	Sedentary Mean (SD) n = 554	p
BMI (kg/m^2)	19.05 (3.85)	19.81 (3.32)	0.016	18.77 (3.43)	19.61 (3.67)	0.013	18.95 (3.36)	19.68 (3.73)	0.001
TST (mm)	14.78 (6.98)	17.15 (7.63)	0.001	16.19 (6.52)	17.44 (6.53)	0.039	15.27 (6.85)	17.33 (6.94)	0.001
% BF	21.29 (6.41)	23.47 (7.23)	0.001	24.35 (5.35)	26.08 (6.04)	0.002	22.35 (6.23)	25.14 (6.61)	0.001
Waist circumference (cm)	71.19 (9.62)	74.07 (11.40)	0.002	69.99 (9.27)	71.98 (9.44)	0.026	70.78 (9.51)	72.73 (10.23)	0.001
Apolipoprotein A-I (mg/dl)	154.13 (21.87)	149.51 (19.76)	0.013	149.16 (19.39)	145.78 (19.62)	0.071	152.42 (21.16)	147.12 (19.74)	0.001
Apolipoprotein B (mg/dl)	62.17 (13.78)	63.54 (13.22)	0.269	62.62 (12.98)	62.74 (13.57)	0.894	62.32 (13.50)	63.03 (13.44)	0.431
Total cholesterol (mg/dl)	159.89 (24.54)	160.47 (23.76)	0.806	158.46 (21.52)	157.92 (24.63)	0.830	159.40 (23.52)	158.83 (24.33)	0.660
Triglycerides (mg/dl)	58.18 (24.22)	67.21 (41.17)	0.002	68.31 (28.96)	70.36 (29.85)	0.484	61.65 (26.36)	69.22 (34.36)	0.001
Fasting insulin (mcIU/ml)	5.56 (3.41)	7.02 (4.66)	0.001	7.77 (4.90)	8.46 (5.59)	0.186	6.32 (4.12)	7.94 (5.31)	0.001
HOMA	1.17 (0.75)	1.50 (1.01)	0.001	1.60 (1.05)	1.79 (1.26)	0.116	1.32 (0.88)	1.68 (1.18)	0.001
SBP (mmHg)	107.19 (9.27)	105.21 (8.94)	0.017	104.76 (9.50)	105.15 (8.45)	0.635	106.35 (9.41)	105.17 (8.62)	0.038
DBP (mmHg)	63.23 (6.55)	63.02 (7.47)	0.749	63.40 (6.34)	64.74 (6.07	0.020	63.29 (6.47)	64.12 (6.65)	0.041
HR at rest (beats/min)	84.20 (9.70)	86.13 (10.05)	0.099	89.91 (10.82)	90.48 (11.34)	0.688	86.08 (10.42)	88.94 (11.08)	0.002
HR after exercise (beats/min)	145.75 (12.31)	150.45 (12.55)	0.002	153.05 (15.05)	151.55 (14.95)	0.426	148.16 (13.69)	151.16 (14.14)	0.008
HR after 1' recovery (beats/min)	88.49 (14.22)	93.62 (15.18)	0.004	104.26 (15.87)	105.46 (15.37)	0.547	93.69 (16.52)	101.27 (16.30)	0.001
Cardiorespiratory	8.43 (2.61)	9.54 (3.05)	0.001	11.17 (3.32)	11.15 (3.17)	0.943	9.33 (3.14)	10.58 (3.21)	0.001

fitness †

† Measured with the Ruffier-Dickson test

BMI = body mass index; TST = tricipital skinfold thickness; %BF = percentage body fat measured by bioimpedance; SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate.

DISCUSSION

A two-item questionnaire for classifying students as either active or sedentary according to CDC recommendations exhibited strong internal consistency and an acceptable convergent validity in students aged 11 to 13 years in Cuenca, Spain.

There has been consistent evidence of a relationship between physical activity and adiposity, lipid profile, baseline insulin, blood pressure and cardiovascular fitness in adults.[21,22] The relationship between physical activity and lipidic, metabolic and anthropometric variables,[23] and with cardiorespiratory fitness[24] in children has been examined in various studies. The relationship between physical activity and blood pressure[25] is not as clear.

Most validation studies of questionnaires for quantifying physical activity in children have used accelerometer measurements of physical activity as the criterion, which have shown weak or moderate correlation coefficients.[26] Few studies have evaluated the construct validity using body composition, biochemical or fitness parameters as convergence criteria. The coefficients of correlation of these parameters with each item separated and with the mean score of both items together are similar to the coefficients of correlation of the Physical Activity Questionnaire for Older Children (PAQ-C) of different races validation study.[27] This is an instrument consisting of 9 items to measure the usual moderate-vigorous intensity physical activity in children aged 8 to 13 years, recently recommended for use but for which a European study has not been done.[10]

To our knowledge, there are three validated questionnaires in English that also have two items. The WHO HBSC questionnaire[11] is the only validated instrument to classify children as active or sedentary. Two reasons prevent us from comparing the results from this study with ours: it does not use the same criteria to categorise children as active or sedentary, and does not use the same testing for convergent validity. The other two instruments have items that are part of the Teen Health Survey[28] and the Finnish Twin Cohort Study,[29] which were designed for adolescents over 14 years so that their applicability in children would be questionable[10].

Another criterion for evaluating the convergent validity of our questionnaire was higher coefficients of correlation obtained on variables such as % BF, baseline insulin, or cardiorespiratory fitness, which have been found to be more consistently related to physical activity in children. Also, when we compared the differences between active and sedentary children, these variables showed the lowest statistical significance.

The variance of measured health indicators was higher in boys than in girls as shown in Table 1, and this could explain the differences in the correlation coefficients between the items of physical activity and health variables (Table 2). These differences, in our view, could be explained by two reasons: firstly, differences in perception of the questions on the questionnaire, and secondly, differences in the sexual maturity of boys and girls, which is known to influence the distribution of body fat and the lipid metabolism profile. One of the limitations of our study was that it did not conform strictly to official physical activity recommendations because it did not quantify the duration of daily physical activity. We believed that temporal perception at this age has great individual variability and that the duration of periods of physical activity could not be quantified in a brief questionnaire.

Since our questionnaire did not capture the duration of physical activity (sedentary, light, moderate and intense), or estimate calorie expenditure, it is difficult to conduct a validation study against the use of accelerometers. Despite this limitation, frequency and intensity are two relevant components of physical activity for differentiating between active and sedentary students in clinical practice and in schools. In these settings, it is often necessary to categorise children in order to make recommendations or prescriptions for changing physical activity habits to the child or the child's family.

Although the use of Cronbach's α has been proposed as an indicator of internal consistency in two items scales,[30] most authors recommend against using this statistic in analyses of reliability in this type of instrument, arguing that it can be interpreted as a summary measure of the relationship between items and that there is no advantage over the correlation coefficient. We share the views of previous studies, and even when this ratio shows acceptable values (0.71) for the two items in the scale that we propose (0.71), we think that this value should not be used as evidence of the internal consistency of the scale.

As the validation of these two items for measuring physical activity was conducted within the context of a randomised clinical trial for the prevention of obesity, the fact that it was not an ad hoc study could be another limitation. Nevertheless, since physical condition was one of the secondary endpoints of the clinical trial and factorial analysis of earlier pilot studies of the CHIP-CE questionnaire had shown that the items referring to the quantification of physical activity could be framed as a dimension of the questionnaire with an eigenvalue greater than 1, we decided to take advantage of the high standardisation of the measurements to validate these two items as an instrument for categorising the physical activity of children. This allowed us to use convergent validity criteria that are unusual in other validation studies and to recruit a large sample.

The future development of our questionnaire should target the evaluation of test-retest reliability and concordance with similar questionnaires. This two-item questionnaire could also be used in validation studies of other instruments that yield quantitative results in order to estimate cutoff points using ROC curves.

CONCLUSION

The scale of two items extracted from and belonging to the CHIP-CE had an acceptable validity and high internal consistency. As a simple, easy and quick-to-use instrument, we think that it unquestionably has practical utility in the clinical and educational context

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