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Development and validation of a physical activity assessment questionnaire for adolescents

ABSTRACT

OBJECTIVE: To develop a physical activity questionnaire aimed at Brazilian adolescents and to assess its validity and reproducibility.

METHODS: A total of 94 adolescents (30 males and 64 females) aged 11-16 years were included in the study, which was conducted in 2004. The questionnaire comprised 17 questions on habitual physical activity in the last 12 months (15 questions on sports and physical exercise and two on transportation physical activity), and was standardized to yield final scores for weekly and yearly activity. As a reference, we used the multistage 20-meter shuttle run test, measuring variables maximum time in minutes, maximum speed, maximum oxygen uptake and maximum heart rate. For validity analysis, we used the Spearman coefficient and age-adjusted correlation. For reproducibility analysis, we repeated evaluations after 15 days and measured the intraclass correlation coefficient.

RESULTS: For the weekly score, the highest correlations were obtained for maximum time for the entire sample ($r=0.19$), maximum speed for males ($r=0.20$), and both maximum oxygen uptake and maximum time for females ($r=0.17$). For the yearly score, the highest correlations were obtained for maximum time for the entire sample ($r=0.30$), maximum heart rate for males ($r=0.22$), and maximum time for females ($r=0.23$). In reproducibility analyses, correlations were 0.61 for weekly score and 0.68 for yearly score.

CONCLUSIONS: The questionnaire was valid and reproducible. Its use is recommended for the evaluation of physical activity in epidemiological studies with adolescents.

KEYWORDS: Adolescent. Physical activity. Physical fitness. Questionnaires. Validation studies. Reproducibility of results.

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INTRODUCTION

The evaluation of physical activity is currently one of the most important fields of epidemiology when focusing on the prevention of non-transmittable chronic diseases. However, instruments for the epidemiological evaluation of physical activity are still scarce in Brazil.

When analysis is restricted to children and adolescents, this is an even greater problem. An instrument currently in wide use for the evaluation of physical activity among Brazilian adolescents is Bouchard's energy expenditure diary, either in its original version⁴ or in a version adapted for adolescents.¹⁸ However, in addition to the complexity of filling out the diary, this method also restricts evaluation to a representative period of the week, which may limit several inferences regarding non-transmittable chronic diseases and their risk factors. Other questionnaires^{9,21} have also been employed, but these lack evidence of validity and reproducibility.

The aim of the present study was to develop a physical activity questionnaire for Brazilian adolescents and to assess its validity and reproducibility.

METHODS

The present study is part of a larger research project* conducted in the city of Piracicaba, Southeastern Brazil.

The study included 94 adolescents (30 males and 64 females) aged 11-16 years, enrolled in a public school in the municipality in 2004.

For sample size calculation, we assumed a correlation of -0.31, the mean correlation coefficient between total time in the 1 mile test and a physical activity score based on a questionnaire obtained among North-American male and female adolescents.¹ Assuming 5% type I error (α) and 20% type II error (β), according to Browner et al,⁶ we arrived at a final sample size of at least 85 adolescents.

The questionnaire was elaborated by researchers with extensive experience in epidemiological surveys of nutritional status and physical activity among adolescents (March 2004). A pretest to verify question consistency was carried out with 20 adolescents of both sexes from a public school in the municipality. Based on these results, we elaborated the final ver-

sion of the instrument, which is included as an Appendix to this article.

The physical activity evaluation questionnaire for adolescents comprises 17 questions divided into two blocks: 1) sport or physical exercise (15 questions) and 2) transportation physical activity (2 questions). It evaluates weekly (blocks 1 and 2) and yearly (block 1) physical activity. The questionnaire was standardized to yield a final score of physical activity in minutes (weekly and yearly). For example, in block 1, based on the type of activity cited, we multiply daily duration in minutes by weekly frequency (minutes per day X weekly frequency) and by months per year of activity (minutes per day X weekly frequency X 4 X months per year). Up to three types of activity are accepted, and, at the end, the sum of the three activities is computed to yield the final score for block 1. In case the adolescent practices more than three types of physical activity, the three he or she considers most important should be prioritized. In block 2, transportation activity (bicycling or walking) has a fixed factor of five times per week, which is multiplied by the number of minutes per day spend on the activity (minutes per day X 5). The results obtained in the pretest showed that yearly evaluation was viable only for block 1. Since recall was difficult for the questions on transportation in block 2, we chose to standardize the weekly score by adding blocks 1 and 2 and to define the yearly score only with basis on block 1.

Physical education in school was included in the pretest, but contributed only slightly to the discrimination between the level of physical activity among adolescents. Moreover, physical education classes for adolescents are of low intensity and do not have significant impact on the improvement of physical aptitude.¹²

In the final stage of validation, the instrument was standardized to be administered as an interview, with a mean administration time of five minutes.

In order to calculate the level of physical activity, one can either consider the final score as a continuous variable, or work with a dichotomous variable using as a cutoff 300 minutes per week of moderate or vigorous physical activity (Pate et al,¹⁷ 2002).

We used as a reference method for comparison with the physical activity questionnaire an evaluation of cardiorespiratory capacity after a 20-meter shuttle-run test.^{15,16} This test is currently in use in Eu-

*Pesquisa "Consumo dietético e atividade física como determinantes das mudanças do índice de massa corporal de uma coorte de adolescentes matriculados na rede pública de ensino da cidade de Piracicaba, São Paulo", responsável Profa. Dra. Betzabeth Slater, do Departamento de Nutrição da Faculdade de Saúde Pública da USP, em 2004-2005.

rope, Canada, the United States,²⁴ and Brazil.* The test consists of a series of sprints across a plain 20 m track, with adolescents sprinting in rhythm to a beep emitted by a cassette player. At each beep, the students must reach one of the extremities marked on the track. The interval between beeps is based on speeds measured in kilometers per hour (km/h), starting at 8 km/h and increasing by 0.5 km/h every minute until the adolescent fails to reach one of the extremities after two beeps.¹⁵ The test was performed in the sports court of the public school attended by the subjects. The track was marked on the court in a 20 meter space. The test was administered to two students at a time, each one supervised by a physical education professional.

To estimate mean oxygen consumption ($\text{VO}_2 \text{ max}$), we used the formula proposed by Leger et al:⁸ $\text{VO}_2 \text{ max (ml/kg/min)} = 31025 + 3238 \text{ X (speed in km/h)} - 3248 \text{ X (age)} + 0,1536 \text{ X (speed X age)}$. We also measured maximum speed (km/h), total time (in seconds), and heart rate at the end of the test (in beats per minute), measured using a frequencymeter (Polar, model A3). Heart rate was measured immediately after the end of the test, when the subject was unable to reach one of the track ends after two beeps in the 20 m shuttle-run. Heart rate is an important variable in cardiorespiratory evaluation, for it holds a linear relationship with maximum oxygen uptake.⁸ To assess reproducibility, measures were repeated 15 days after the first evaluation, using the same criteria for evaluation.

Anthropometry was evaluated by measuring body weight, stature, and waist circumference. To measure body weight, adolescents wore light clothing and no shoes, and were positioned on an electronic platform scale (Camry ED-309, 150 kg capacity; 100 gram sensitivity). For the evaluation of stature, we used a wooden fixed stadiometer, with a scale in millimeters. For this measurement, subjects remained with both feet together and heels touching the wall, in erect position, looking straight at the horizon (or with heads adjusted in the Frankfurt plane). We calculated body mass index (BMI) by dividing weight (kg) by the square of height (m). For the evaluation of waist circumference, we used a fiberglass tape measure (Sanny). The measurement was performed two centimeters above the navel, and two measurements were made, the mean value in centimeters being adopted.

Variables were analyzed descriptively using means, standard deviations, and minimum and maximum values. Using the Kolmogov-Smirnov test, we found

that all physical activity scores had non-parametric distributions. In order to determine differences between boys and girls in terms of the studied variables, we used the Kruskal-Wallis test.

For test validation, we used the crude Spearman's correlation coefficient (r_{sho}) between physical activity scores (min) and maximum oxygen uptake (ml/kg/min), maximum speed (km/h), total time (seconds), maximum heart rate, age (years), and waist circumference (cm) for boys and girls, evaluated both separately and as a single group.

We used a correlation coefficient adjusted for age to control for the effect of maturational stage. For reproducibility analysis, we used the intraclass correlation coefficient (r_{icc}), comparing the first and second measures.

The present survey was approved by the Research Ethics Committee of the Faculdade de Saúde Pública da Universidade de São Paulo. All subjects provided authorization from parents or guardians for participation in the study.

RESULTS

Table 1 shows the descriptive analysis of results. Mean BMI and waist circumference were greater among girls. All physical fitness values were higher among boys, as were annual physical activity scores, showing that boys were more active than girls. Six adolescents were lost to validation analysis due to failure to participate in the physical fitness tests.

Table 2 shows correlation coefficients, both crude and adjusted for age, between reference variables and physical activity scores. Crude analysis of all physical activity variables showed that coefficients were higher for yearly than for weekly physical activity, and higher for stratified analysis. In crude analysis stratified by sex, correlation coefficients for weekly physical activity were higher than those for yearly activity among boys. The inverse relationship was found among girls, with higher correlation coefficients for yearly than for weekly physical activity. These values remained constant after adjustment for age. We found a negative correlation between both weekly and yearly scores and waist circumference.

Regarding reproducibility (Figure), our results showed that both scores showed intraclass correlation coefficients above 0.60.

*Florindo AA, Cotta L, Bessa ECS, Santos LM, Kiss MAPDM, Lima JRP, et al. Medida da velocidade no ponto de deflexão da frequência cardíaca no teste de Course Navette. In: Proceedings do 2º Congresso de Iniciação Científica da Escola de Educação Física da Universidade de São Paulo; 1995; São Paulo, Brasil. São Paulo, Escola de Educação Física e Esporte; 1996. p. 29.

Table 1 - Description and comparison of means according to sex of study variables among adolescent students of a public school in the city of Piracicaba, Southeastern Brazil, 2004.

Variable	Overall		Male		Female		p
	Mean (sd)	Min-max	Mean (sd)	Min-max	Mean (sd)	Min-max	
Age (years)	13,0(1,1)	11,0-16,0	12,2 (0,8)	11,0-14,0	13,3 (1,1)	12,0-16,0	<0,001
Body mass index (kg/m ²)	20,5(3,8)	14,3-34,0	19,1 (3,6)	14,3-31,5	21,1 (3,8)	14,7-34,0	0,005
Waist circumference (cm)	72,0(11,1)	28,3-105,0	68,4(12,4)	28,3-93,3	73,7(10,1)	56,0-105,0	0,035
VO ₂ max (ml/kg/min) ⁻¹	40,6(6,1)	29,4-58,1	46,5 (5,5)	37,8-58,1	37,8 (4,0)	29,4-49,0	<0,001
Total speed (km/h)	9,9(1,0)	8,5-13,0	10,8 (1,0)	9,0-13,0	9,5 (0,7)	8,5-11,5	<0,001
Total time (seconds)	265,3(122,8)	70,0-642,0	377,1 (118,5)	173,0-642,0	213,1 (84,3)	70,0-469,0	<0,001
Maximum heart rate	196,2(9,6)	171,0-218,0	197,5 (9,6)	178,0-218,0	195,6 (9,7)	171,0-215,0	0,432
Weekly physical activity*	502,0(433,4)	0,0-1940,0	587,3(443,3)	60,0-1770,0	462,0(426,3)	0,0-1940,0	0,126
Yearly physical activity**	11204,0(15115,3)	0,0-80640,0	18040,0(20401,1)	0,0-80640,0	7999,7(10630,1)	0,0-53280,0	0,005

*Score in minutes/week; **Score in minutes/year

DISCUSSION

We found in the literature no questionnaires evaluating habitual physical activity (relative to the preceding 12-month period) validated for Brazilian adolescents. Therefore, the present study is a pioneer in obtaining evidence of validity and reproducibility of a habitual physical activity questionnaire in a sample of adolescents from a Brazilian public school.

One of the instruments most frequently used for evaluating physical activity is the International Physical Activity Questionnaire (IPAQ).^{*} Designed to assess the frequency and duration of moderate and vigorous physical activity during the week preceding administration, this questionnaire was originally validated to be administered to subjects aged 16-65 years in several countries, including Brazil.

Specifically with regard to Brazilian adolescents, an instrument that has been frequently used for evaluating physical activity is the Bouchard Diary,⁴ which has previously been adapted and validated for use with adolescents.¹⁸ However, since this is a diary that must be filled out every 15 minutes, there are difficulties regarding control and refusals, which often prevent its use in epidemiological research. Moreover, this instrument is limited to the evaluation of weekly physical activity. Other questionnaires used in Brazilian epidemiological surveys have either been only translated, without obtaining evidence regard-

ing validity among Brazilian adolescents,²¹ or have consisted of general questions such as time spent sitting, standing, walking, or running, with no evidence of validity or reproducibility.⁹

Our results show evidence of validity in the correlation with indicators of cardiorespiratory capacity in both sexes, even after adjustment for age. Correlation coefficients were higher than those found by Booth et al³ for Australian boys aged 13-15 years. These authors assessed the correlation between number of laps in the 20 m shuttle-run and the score obtained in a questionnaire of physical activity in metabolic equivalents (MET), finding a correlation coefficient of $r_{\text{sho}}=0.14$. In the present study, we obtained a coefficient of $r_{\text{sho}}=0.20$ between maximum speed and weekly score. However, the Australian study obtained better results for girls ($r_{\text{sho}}=0.30$ vs $r_{\text{sho}}=0.23$ for total time and yearly score in the present study).

Another two studies^{1,7} carried out with North-American adolescents showed correlation coefficients of $r=0.28$ for maximum oxygen uptake obtained using the step test for boys and girls analyzed together. This study obtained a physical activity score in MET/hour, and coefficients of $r=-0.20$ for boys and $r=-0.47$ for girls in the correlation between total time in a one-mile test and yearly score in MET/hour. The results of the weekly and yearly scores for boys are similar to those found in the present study.

The comparison of a weekly physical activity ques-

Table 2 - Crude Spearman correlation coefficients (r_{sho}) and coefficients adjusted for age between weekly and yearly physical activity scores and physical aptitude variables, age, and waist circumference. Piracicaba, Southeastern Brazil, 2004.

Reference variables	Weekly physical activity score (minutes)						Yearly physical activity score (minutes)					
	Overall		Boys		Girls		Overall		Boys		Girls	
	r	r _{adjusted}	r	r _{adjusted}	r	r _{adjusted}	r	r _{adjusted}	r	r _{adjusted}	r	r _{adjusted}
VO ₂ max (ml/kg/min) ⁻¹	0.18	0.15	0.15	0.15	0.17	0.11	0.28**	0.23	0.08	0.11	0.21	0.10
Total speed (km/h)	0.15	0.14	0.20	0.15	0.10	0.11	0.24*	0.23	0.15	0.12	0.13	0.10
Total time (seconds)	0.19	0.14	0.18	0.11	0.17	0.11	0.30**	0.26	0.15	0.10	0.23	0.17
Maximum heart rate	0.05	0.10	0.15	0.22	-0.01	0.02	0.08	0.16	0.04	0.13	0.11	0.08
Age (years)	-0.10	—	0.14	—	-0.10	—	-0.16	—	0.23	—	-0.13	—
Waist circumference (cm)	-0.12	—	-0.26	—	-0.02	—	-0.06	—	-0.20	—	0.12	—

*p<0.05; **p<0.01

tionnaire and results expressed in MET using an accelerometer showed correlation coefficients of $r_{\text{sho}}=0.54$ for boys and $r_{\text{sho}}=0.35$ for girls in a Dutch study including subjects aged 11-12 years.¹⁹ A study²² with Swedish adolescents compared energy expenditure measured using doubly labeled water with energy expenditure by means of a questionnaire measuring activity in MET, finding correlation coefficients of 0.39 for boys and girls analyzed as a single group.

Although correlation coefficients in the present study were lower than those of most studies found in the literature, they are acceptable from the perspective of validity in comparison with physical fitness standards.²⁰ As to the results of the Spearman correlation coefficients being lower than those found in developed countries, we believe that this may have been due either to the reference method used, or to recall bias.

Regarding the reference method, the physical fitness test used in the present study is standard for cardiorespiratory analysis of adolescents²⁴ and has been previously used in adolescents in the municipality of Sao Paulo* and as a standard for the validation of a physical activity questionnaire for Australian adolescents.³ Variables related to physical fitness show a relationship with habitual physical activity. A recent review²³ summarized several surveys that show that cardiorespiratory fitness is under direct influence of the practice of sports and physical activities among adolescents. However, cardiorespiratory evaluation alone may be too limited to be related to certain non-structured daily activities, such as transportation activity. Furthermore, maximum oxygen uptake is influenced by genetic factors, thus limiting its use as a reference standard for comparison with physical activity scores.⁵ In this case, one of the best reference methods for the evaluation of physical activity are movement sensors, such as pedometers and accelerometers. However, these methods have operational problems, especially regarding instrument control, given that subjects are required to wear the sensors for at least three days in the week in order to obtain an accurate evaluation of current physical activity. In the case of adolescents, this may hinder instrument control even further. This problem does not affect cardiorespiratory evaluation performed in the

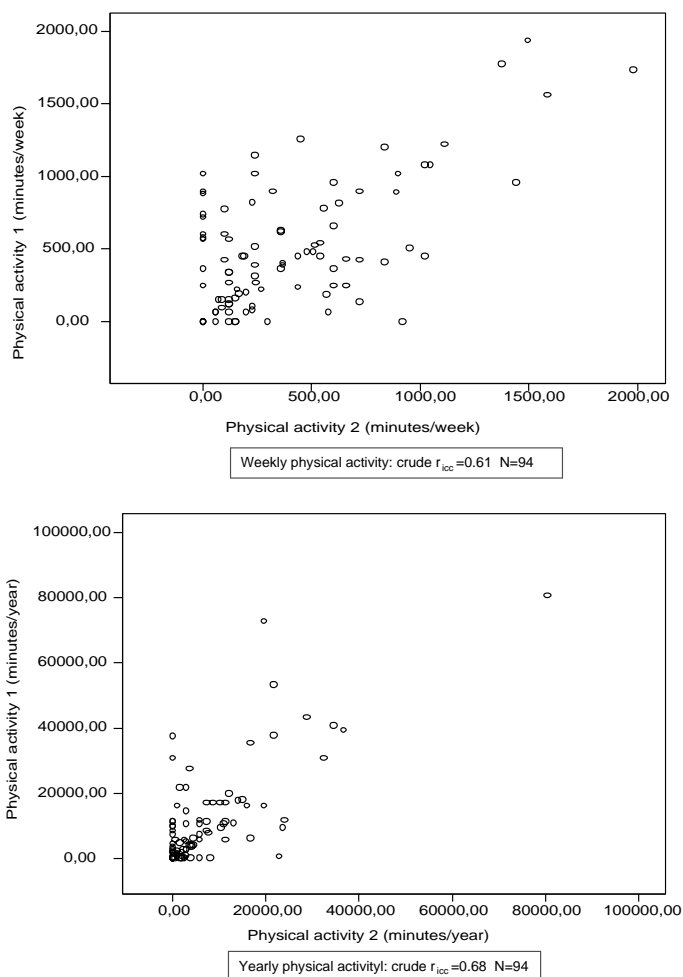


Figure - Intraclass correlation coefficients for repeated measures for the weekly and yearly scores of the physical activity questionnaire.

field or in a laboratory. Further evidence, reviewed in a recent article,²⁵ showed that the number of daily steps measured by a pedometer was positively associated with cardiorespiratory fitness among adolescents, adults, and elderly subjects (mean $r=0.41$ for total time in a treadmill test and mean coefficient $r=0.22$ for maximum oxygen uptake).

Recall bias is an issue in questionnaire-based evaluation of physical activity, especially when working with adolescents.² Adolescents tend to either overestimate (active adolescents) or underestimate (obese adolescents) physical activity, and this can increase the variability of measurements, leading to weaker correlations.¹⁰

Correlation coefficients were stronger for the yearly than for the weekly score. This may be due to cardiorespiratory fitness being more strongly influenced

*Florindo AA, Cotta L, Bessa ECS, Santos LM, Kiss MAPDM, Lima JRP, et al. Medida da velocidade no ponto de deflexão da frequência cardíaca no teste de Course Navette. In: Proceedings do 2º Congresso de Iniciação Científica da Escola de Educação Física da Universidade de São Paulo; 1995; São Paulo, Brasil. São Paulo, Escola de Educação Física e Esporte; 1996. p. 29.

by habitual physical activity, characterized by the practice of sports or physical exercise.⁸

Questionnaires assessing habitual physical activity may show problems related to seasonal variation, especially in countries with cold winters, which can limit their administration in all four seasons.¹ However, in tropical countries such as Brazil, seasonality is not regarded as a substantial problem in the evaluation of physical activity due to the warm winters. Furthermore, in the present study, correlation coefficients obtained for yearly physical activity were stronger than those for weekly activity.

The analysis of reproducibility showed satisfactory results for boys and girls analyzed as a single group

(intra-class correlation coefficients greater than 0.60). These r_{icc} coefficients were stronger than those obtained in reproducibility studies with two-week intervals among Australian adolescents of both sexes ($r_{icc}=0.59$)³ and among Canadian adolescent girls¹⁴ ($0.44 < r_{sho} < 0.59$, for four questionnaires). On the other hand, these coefficients are lower than those reported in a study of North-American adolescents ($r=0.78$; $r_{sho}=0.89$;¹³ and $r_{sho}=0.85$).^{1,8}

The results of the present study show evidence that the questionnaire developed for the evaluation of physical activity among adolescents is valid and reproducible. We recommend the use of this questionnaire for the evaluation of habitual physical activity in epidemiological surveys among adolescents.

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APPENDIX

Final version of the habitual physical activity questionnaire

1. Have you practiced sports or physical exercise in clubs, gyms, sports schools, parks, streets, or at home in the last 12 months?
 2. Which sport or physical exercise did you practice with most frequency?
 3. How many hours per day did you practice this activity?
 4. How many days per week did you practice this activity?
 5. How many months per year have you practiced this activity?
 6. Have you practiced a second sport or physical exercise? 1. Yes 2. No
 7. Which sport or physical exercise did you practice?
 8. How many hours per day did you practice this activity?
 9. How many days per week did you practice this activity?
 10. How many months per year have you practiced this activity?
 11. Have you practiced a third sport or physical exercise? 1. Yes 2. No
 12. Which sport or physical exercise did you practice?
 13. How many hours per day did you practice this activity?
 14. How many days per week did you practice this activity?
 15. How many months per year have you practiced this activity?
 16. Do you usually walk or ride a bicycle to school? 1. Yes 2. No
 17. How many yours per day do you spend in these activities?
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