

Fernando Adami<sup>I,II</sup>

Denise Pimentel Bergamaschi<sup>II</sup>

Patrícia de Fragas Hinnig<sup>II</sup>

Natália Sanchez Oliveira<sup>II</sup>

# Validity study of the “Physical Activity Checklist” in children

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## ABSTRACT

**OBJECTIVE:** To assess the validity and operational equivalence of the “Physical Activity Checklist” in children.

**METHODS:** This study complements the cross-cultural adaptation of the Physical Activity Checklist Interview, conducted with 118 school children aged between seven and ten years old, enrolled from the second to the fifth grades of primary education in the city of São Paulo, SP, Southeastern Brazil, in 2009. The questionnaire enables the quantification of time spent in moderate and vigorous physical activities and sedentary activities and the total and weighted metabolic costs. The accelerometer was adopted as a criterion measure of physical activity. The variables total physical activity (counts/min) and time spent in moderate to vigorous physical activity were quantified. The concurrent validity was assessed by Pearson’s correlation coefficient while the operational equivalence was assessed by data concerning the duration and evaluation of the interview.

**RESULTS:** The values for the correlation coefficient between the results from the questionnaire and the accelerometer ranged from 0.34 to 0.40. It was found that LAF overestimates time spent doing moderate and vigorous physical activity when compared to the accelerometer. The average duration of the interviews was 24 minutes (minimum = 13 min, maximum = 41 min, sd = 5 min). The interview item showing the poorest result was the children’s ability to estimate time (poor or fair in 24.8% of interviews).

**CONCLUSIONS:** In relation to the original version, the questionnaire “Physical Activity Checklist” presents similar indices of concurrent validity and operational equivalence, confirming the appropriateness of the cross-cultural adaptation.

**DESCRIPTORS:** Child. Motor Activity. Health Evaluation. Questionnaires. Validity of Tests. Reproducibility of Results.

<sup>I</sup> Programa de Pós-Graduação em Ciências da Saúde. Departamento de Saúde da Coletividade. Faculdade de Medicina do ABC. Santo André, SP, Brasil

<sup>II</sup> Programa de Pós-Graduação em Saúde Pública. Departamento de Epidemiologia. Faculdade de Saúde Pública. Universidade de São Paulo. São Paulo, SP, Brasil

### Correspondence:

Denise Pimentel Bergamaschi  
Av Dr Arnaldo, 715  
01246-904 São Paulo, SP, Brasil  
E-mail: denisepb@usp.br

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## INTRODUCTION

Physical activity is a multi-dimensional construct (leisure, occupational, domestic and transport activities) and is epidemiologically important due to its link with health outcomes for those of all ages.<sup>11</sup> In children, physical activity is a contributing factor to healthy bones and immune system, psycho-social health, cognitive development, preventing chronic disease such as high blood pressure, diabetes mellitus and obesity in adulthood.<sup>23</sup>

The literature indicates that measuring physical activity in children is a challenge compared to adults, due to the characteristics of this activity and the cognitive and linguistic development of this age group. In epidemiological research, questionnaires are recognized as viable measuring instruments due to their low cost and ease of use. However, they have limitations, such as being dependent on memory and on the interviewers capacity to use them, which can interfere in the accuracy and reliability of the data obtained.<sup>3,7,19</sup> Objective methods, such as accelerometry, are widely used with children. This method, however, does not allow the type of activity to be identified.<sup>26</sup>

In Brazil, there is a lack of quantitative questionnaires with their reliability and validity assessed and presenting lists of physical activities usually carried out by children, which would enable energy expenditure to be estimated. Barros et al<sup>3</sup> (2007) evaluated the psycho-metric properties of the “Food and Physical Activity in a Typical Day” (FPAD) questionnaire, developed for children aged from seven to ten in Florianopolis, SC, Southeastern Brazil, and found good reproducibility and moderate evidence of validity, assessed by comparing FPAD with parents’ and teachers’ reports.

This gap may be filled by developing new instruments or considering the transcultural adaptation process of instruments developed in other countries, whose psycho-metric properties have been evaluated.<sup>16</sup>

Transcultural adaptation consists of specific methodological steps which guide the process of drawing up a version of an instrument previously validated in another culture for the target culture. It involves considering conceptual, semantic, operational and measuring equivalences.<sup>10,16</sup>

Cruciani et al<sup>8</sup> (2011) followed the stages for assessing the conceptual and semantic equivalence of the items of the Physical Activity Checklist Interview (PACI)<sup>21</sup> questionnaire, developed for American children to assess their physical activity (the Brazilian version of which is called – “Lista de Atividades Físicas” LAF Physical Activity Checklist). As part of the measuring equivalence Adami et al<sup>1</sup> (2011) verified the reliability of the LAF in children aged seven to ten, with results

indicating high levels of accuracy (intra-class coefficient of correlation > 0.84).

This study aimed to evaluate the validity and operational equivalence of the LAF questionnaire.

## METHODS

Methodological study carried out with 118 schoolchildren aged from seven to ten, drawn from 240 enrolled in the second to fifth year of Primary education in a public school in the municipality of Sao Paulo, SP, Southeastern Brazil, from August to December 2009. For calculating the sample size, the following parameters were adopted:  $\alpha = 0.05$ ,  $\beta = 0.10$  and the value of Pearson correlation between the methods of assessment ( $\rho$ ) was set to be equal to 0.3.<sup>12</sup>

Of the 118 children, nine were not included in the analysis due to: being aged over 11 ( $n = 2$ ); the total time using the *accelerometer* was less than 600 minutes ( $n = 2$ ); outliers in the variable total physical activity (counts in one minute) ( $n = 1$ ); not having been in class on the day prior to the LAF being conducted ( $n = 1$ ); poor notion of time, identified in the instructions for the LAF interview ( $n = 3$ ). There were 109 schoolchildren included in the statistical analysis (59 boys and 50 girls) with a mean age of 9.1 years old (minimum value = 7.2; maximum value = 11.0; standard deviation = 1.0 year).

The LAF is a questionnaire administered through an interview regarding school days which enables children’s physical activity on the previous day to be assessed.<sup>1,8</sup> Based on a list of 21 physical activities of moderate to vigorous intensity in which the Metabolic Equivalent of Task (MET) is equal to or more than 3 MET, the children report time periods of more than five minutes spent in these activities before, during and after school and the perceived exertion. There is space to add time spent on other physical activities, watching television, using video games and computers. The LAF includes an initial section named Interview Instructions, composed of guidance for completion and information for the interviewer carrying out the interview and verifies the child’s level of understanding of concepts related to estimating the time spent in the physical activity. At the end of the instrument is section C, used for the evaluation of the interview,

The LAF is used to quantify: i) time spent in sedentary activities (SA); ii) time spent in moderate and vigorous physical activity (PA); iii) total metabolic cost of the reported activities (min x MET value of each activity – TMC); iv) weighted total metabolic cost (min x MET value of each activity x weighting given according to perceived exertion TMCw).

Perceived exertion for each physical activity is defined using the question “When you <ycled> for five minutes or more yesterday <before school>, did you get out of breath or feel tired *at all, some of the time, most of the time?*”. Following the recommendations of the original study,<sup>21</sup> if the child reports activities of moderate intensity (MET up to 5.9), the TMC value is multiplied by 1.1 (*sometimes*) or 1.25 (*most of the time*). In the LAF, the MET values obtained should come from the Ainsworth Compendium of Physical Activities by Ainsworth et al<sup>2</sup> (1993), as in the original questionnaire.

The *ActiGraph accelerometer*, model GT1M, which has piezoelectric sensors and microprocessors that convert the accelerations of the individual in a measure called counts, reflecting the frequency and intensity of movement, was adopted to assess the concurrent validity of the LAF.<sup>28</sup> Acceleration signals are captured and digitalized by an analog-digital converter at a rate of 30 times per second (30 Hertz), being later summed into a period called an epoch. In this study, the accelerometer is programmed to store counts with an epoch of one minute, as adopted in the original study by Sallis et al<sup>21</sup> (1996).

As an indicator of total physical activity, the mean counts per day (counts/min) was quantified, calculated as the ratio between the sum of counts in one day and the amount of time the device was used, removing from the denominator the periods in which the device was not in use, identified as 20 or more consecutive minutes of zero.<sup>13,23</sup> As an indicator of the time spent in moderate and vigorous physical activity, a cutoff point of 2,000 counts/min was adopted.<sup>13,21</sup> Valid total time using the accelerometer was considered to be 600 or more minutes.<sup>6</sup>

The accelerometer was secured to the left hip, above the iliac crest, using an elastic strap and the child was instructed to use it continually except when sleeping at night and I activities involving water. The accelerometer was put in place during school time (evening) on a specific day (day 1) and removed two days later (day 3), with the analysis referring to one complete day of use (day 2). As the LAF takes into account data on the preceding day, it was carried out on day 3, thus ensuring that the day captured by the LAF coincided with the day for which the accelerometer recorded data.

In order to adhere to use of the device: i) the children’s parents or guardians were informed by telephone, shortly before the accelerometers were put in place, of the procedures for their use; ii) trained researchers advised the children individually about how to secure and use the accelerometer; iii) the children were alerted, by telephone, on the morning on which the accelerometer was to be used; iv) on the afternoon of the same day, researchers spoke with each child to check whether there was any problem with using the device.

Training was carried out with three researchers involved in the project, the methodology of which consisted in explanations about the research and the LAF questionnaire; reading and discussing the LAF and instructions regarding the interview and procedures for collecting the accelerometer data.

Data from the LAF were inputted twice, with the input verified using the EpiInfo software; the data from the accelerometers were transferred to a microcomputer using ActiGraph software, the variables total physical activity and time spent in moderate and vigorous physical activity were obtained using routine computation developed in Java programming language.

Concurrent criterion validity was investigated using Pearson’s product-moment correlation between results from the LAF and the accelerometer. The correlation coefficient values were compared to those of the original study to assess the validity of the adapted version of the PACI.<sup>21</sup>

The differences between the time spent in moderate and vigorous physical activity obtained from LAF and from the accelerometer were described using *boxplot*. The operational equivalence of the LAF was assessed by analyzing the length of the interview and the results in Section C.<sup>15</sup> The Stata, version 10.0 was used for the statistical analysis.

The study was approved by the Research Ethics Committee of the *Faculdade de Saúde Pública, Universidade de São Paulo* (Protocol n° 1598, approved on 12<sup>th</sup> November 2007). The children’s parents or guardians signed a consent form.

## RESULTS

No difference was found between sexes for the total time using the accelerometer, the mean of which, for both, was 831.2 minutes (95%CI 815.2;847.2 min) (Table 1).

According to the accelerometer, boys had higher mean values for total physical activity (counts/min) and time spent in moderate and vigorous physical activity, suggesting that they are more active than girls.

Such differences between the sexes were not observed using data from LAF, even when comparing the time spent in sedentary activities. In both sexes, the mean time spent in moderate and vigorous physical activity (PA) was 89 minutes (95%CI 78;100 min); and 111.8 minutes in sedentary activities (SA) (95%CI 94.4;129.3 min). The mean values and 95%CI of total metabolic cost (TMC) weighted total metabolic cost (TMCw) of the activities reported were 530.2 MET (95%CI 461.1;599.2 MET) and 495.3 MET (95%CI 432.1;558.5 MET), respectively.

**Table 1.** Mean values for daily physical and sedentary activities obtained from the accelerometer and the List of Physical Activities (LAF) questionnaire according to sex. Sao Paulo, Southeastern Brazil, 2009.

Variable	Male (n = 59)	Female (n = 50)	Total (n = 109)
Total time using the accelerometer (min) <sup>a</sup>	838.0 (815.6-860.3)	823.2 (799.7-846.7)	831.2 (815.2-847.2)
Total physical activity (counts/min) <sup>a</sup>	567.5 (526.5-608.5)	470.5 (434.1-506.9)	523.0 (494.1-551.9)
Time spent in physical activity – counts > 2,000 (min) <sup>a</sup>	69.2 (61.0-77.3)	44.4 (38.1-50.6)	57.8 (52.1-63.5)
Time spent in physical activity (minutes) <sup>b</sup>	97.8 (83.4-112.2)	78.6 (61.6-95.7)	89.0 (78.0-100.0)
Total Metabolic Cost (MET) <sup>b</sup>	611.3 (517.7-705.0)	434.4 (335.5-533.3)	530.2 (461.1-599.2)
Weighted Total Metabolic Cost (MET) <sup>b</sup>	557.4 (475.7-639.1)	422.1 (324.5-519.6)	495.3 (432.1-558.5)
Time spent in sedentary activities (minutes) <sup>b</sup>	129.6 (103.4-155.9)	90.8 (69.2-112.5)	111.8 (94.4-129.3)

<sup>a</sup> Data estimated based on the accelerometer

<sup>b</sup> Data estimated based on the LAF

Investigation of the relationship between the indicators of physical activity obtained by the LAF and the accelerometer, using Pearson's coefficient of correlation, indicated values between 0.34 and 0.40, as shown in Table 2. The variable sedentary activity showed no significant correlation with the variable from the accelerometer (data not shown).

There was positive linear trend of the data in the scatter plot, with poor magnitude (Figure a). For the boxplot, displaced values above zero were observed, indicating higher estimates for the LAF. There were outliers below and above the adjacent lower and upper limits (Figure b).

The mean length of the interview was 24 minutes (minimum value = 13 minutes; maximum = 41 minutes; sd = 5 minutes). In the general evaluation of the questionnaire, 11.9% of the interviews were classified as regular, the rest (88.1%) as good, very good or excellent (Table 3). The participant's ability to estimate time was the item evaluated by the interviewer which had the highest proportion of cases classified as bad/regular (24.8%); 75.2% had a good, very good or excellent grasp of the concept.

**Table 2.** Values for the coefficient of Pearson's product-moment correlation (r) between the variables for the List of Physical Activities (LAF) and those of the accelerometer. Sao Paulo, Southeastern Brazil, 2009.

LAF Accelerometer	Time spent in physical activity (minutes)	Total Metabolic Cost (MET)	Weighted Total Metabolic Cost (MET)
r (p)			
Total physical activity (counts/min)	0.34 (< 0.001)	0.38 (< 0.001)	0.34 (< 0.001)
Time spent in physical activity (minutes)	0.36 (< 0.001)	0.40 (< 0.001)	0.35 (< 0.001)

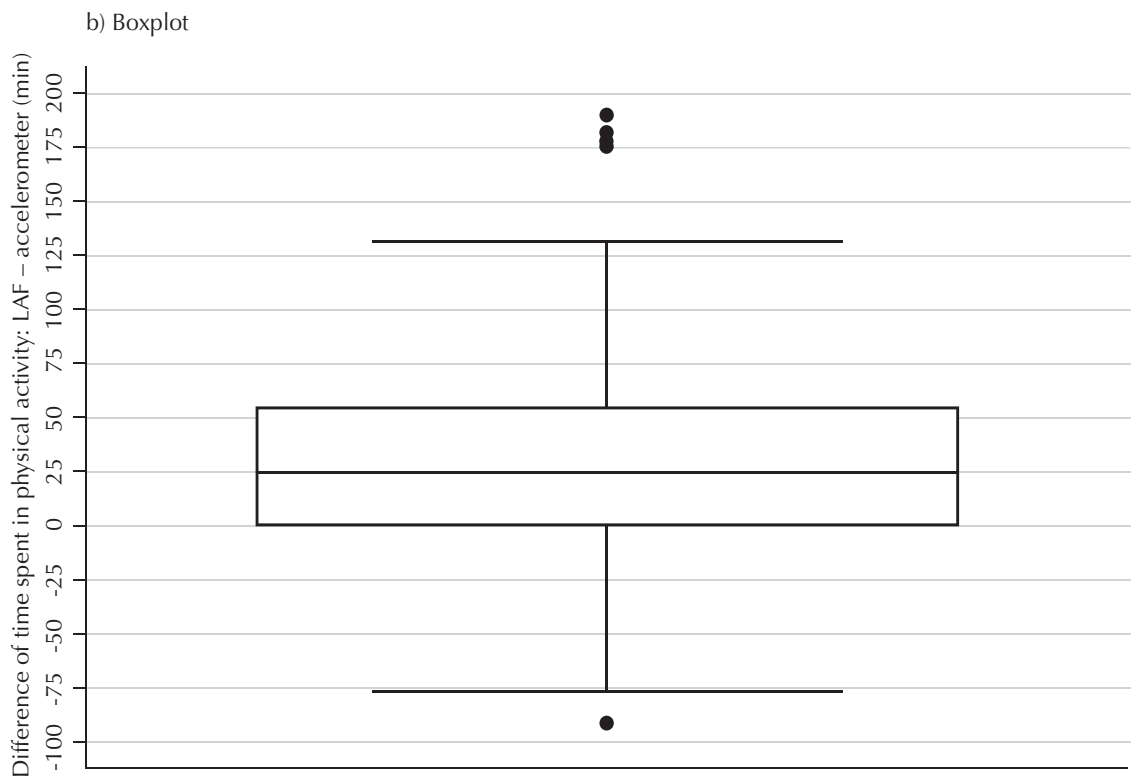
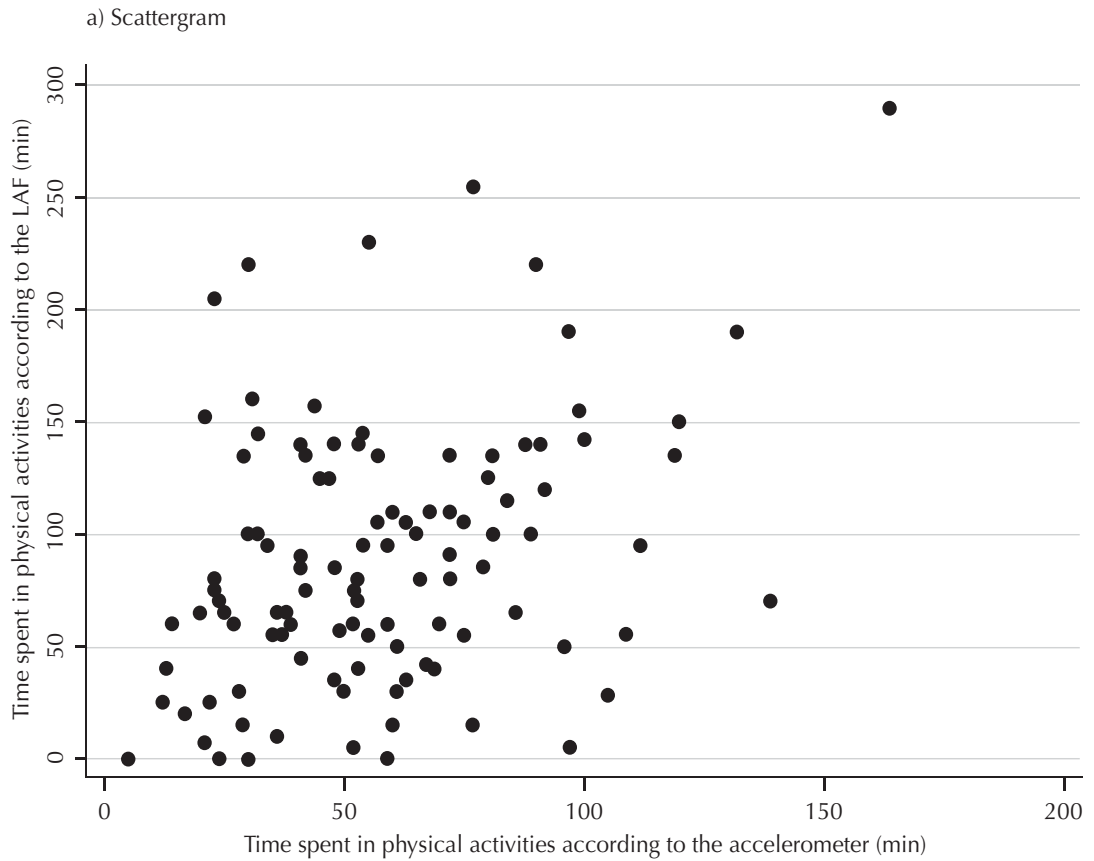
MET: Metabolic Equivalent of Task

## DISCUSSION

The results indicate that the adapted version of the PACI, compared with the original, has similar values for correlation coefficient between the instrument's indicators of physical activity (PA, TMC and TMCw) and the indicator of total physical activity (counts/min) from the accelerometer (respectively 0.34, 0.38 and 0.34 in this study and 0.32, 0.38 and 0.38 in the original study). The LAF has greater values for precision<sup>1</sup> and accuracy similar to those of the PACI. Together with the results of the evaluation of the items' conceptual and semantic equivalence,<sup>8</sup> it can be seen that there is equivalence between the versions with regards aspects of concept, meaning and psychometric qualities, attesting to the quality of the transcultural adaptation process.

Estimates of the coefficient of correlation between the LAF and the accelerometer, although indicating poor magnitude, are similar or higher than those found in the majority of international studies validating other questionnaires for children and which adopt the accelerometer as a measure: 0.10;<sup>22</sup> 0.21;<sup>17,25</sup> 0.34.<sup>20,27</sup>

It might be thought that the cutoff point of 2,000 counts/min for classifying moderate and vigorous physical activity was high for this age group. This would partly explain the fact that the LAF overestimates physical activity compared with the accelerometer, resulting in poor magnitude of correlation. However, when using the indicator of total physical activity (counts/min), the magnitude of correlation remained poor, possibly due to the nature of what is being measured. Physical activity especially in this age group is neither constant nor uniform in its intensity.<sup>5</sup> Children, when reporting the movement carried out, may not perceive this intermittence and report periods of physical activity of a uniform intensity. The results of this study corroborate data in the literature which indicate that time spent in physical activities is overestimated when measured using questionnaires.<sup>15</sup>



**Figure.** Analysis of time spent in moderate to vigorous physical activity according to the (LAF) and the accelerometer: a) scattergram; b) boxplot of the difference between the LAF and the accelerometer. Sao Paulo, SP, Southeastern Brazil 2009.

**Table 3.** Distribution of the number of schoolchildren according to the evaluation of the interview to fill out the List of Physical Activities (LAF). Sao Paulo, Southeastern Brazil, 2009.

Concepts	Overall assessment		Participant's attention		Ability to remember activities		Ability to estimate time passing		Level of cooperation		Credibility of the interview	
	n	%	n	%	n	%	n	%	n	%	n	%
Very bad	1	0.9	1	0.9	3	2.8	5	4.6	0	-	1	0.9
Regular	13	11.9	11	10.1	11	10.1	22	20.2	6	5.5	13	11.9
Good	31	28.4	18	16.5	32	29.4	32	29.4	15	13.8	34	31.2
Very good	48	44.0	47	43.1	45	41.3	30	27.5	46	42.2	47	43.1
Excellent	16	14.7	32	29.4	18	16.5	20	18.4	42	38.5	14	12.8

Issues related to cutoff points for classifying levels of physical activity are debated in the literature. In a systematic review, Romanzini et al<sup>19</sup> (2012) suggest that using 1,900 to 3,600 and 3,900 to 8,200 counts/min to identify moderate and vigorous physical activity respectively, in six to eighteen-years-olds, would enable good validity to be obtained. However, other studies, with larger samples, are necessary to represent the reality in Brazil.

Estimating the time spent doing the moderate and vigorous physical activities was affected by the counts' storage time (e.g., one minute *versus* 15 seconds). Studies have shown a greater influence of the length of the epoch in cases in which evaluating the intensity of the physical activity is of interest, mainly for those which are intermittent, such as activities carried out at recess. However, this is not a problem in situations in which only the total time spent in physical activities is quantified. The choice of epoch length is the object of a study in evaluating physical activity in children.<sup>9</sup>

Another methodological challenge is related to the dimensions of the construct. In the vast majority of studies, physical activities related to leisure, occupational, domestic and transport activities are not presented separately. Barros et al<sup>3</sup> (2007), in their qualitative questionnaire, presented a wider vision of these dimensions. It is possible that the respondents had difficulty identifying the intensity of the physical activity using the instrument's diagrams.

In the literature, there is no clear definition of the construct of sedentary activity. The lack of correlation found between data on sedentary activities from the LAF and those of physical activities from the accelerometer may be explained by the difficulties of measuring this concept. In spite of the original questionnaire containing a field for recording sedentary activity, there are no indicators of the validity of this construct.<sup>21</sup>

The mean length of interviews in the original study was 17 minutes,<sup>21</sup> lower than that of this study (24 min), probably due to the difference in ages; the mean age in the study by Sallis et al<sup>21</sup> (1996) was 10.9 *versus* 9.2

in this study. The results from the PACI<sup>21</sup> indicate that the percentages of interviews evaluated as very good or excellent were (Section C): i) participant attention: 67%; ii) ability to remember activities: 54%; iii) ability to estimate time: 41%; iv) level of cooperation: 83%; v) credibility of the interview: 53%; vi) overall assessment of the interview: 56%. For the LAF, these values were, respectively, 72.5%, 57.8%, 45.9%, 86.7%, 55.9% and 58.7%, similar to the original study. The results of the studies indicate the difficulty children have in estimating the time spent engaged in activities the previous day.

It can be concluded, therefore, that there is evidence of similarity between the operational aspects of the instrument's use with the target and source populations. There was found to be operational equivalence, as it was possible to reproduce the *modus operandi* of the source culture with the target culture. According to Reichenheim & Moraes<sup>16</sup> (2007), measurement equivalence is partly attested to by the appropriateness of the measuring process indicated by operational equivalence. Evidence of criteria validity was confirmed by the existence of correlation values similar to those of the original version.

The LAF has some important characteristics as an instrument for measuring physical activity in children: it is in the form of an interview; it evaluates the previous day's activities; the children respond to the questionnaire of a list of physical activities; the day is divided up according to school routine and there are instructions to guide the interviewer.<sup>17</sup>

Interviews are a strategy to improve the accuracy of the data and is preferable to the respondent filling out the questionnaire themselves. The interview may give more control, allowing those children who have cognitive difficulties responding to the questionnaire to be identified, something which would be difficult were the children to complete the questionnaires themselves.<sup>7</sup>

Questionnaires about the previous day are those most often used in research with children and are more

appropriate for use with this population due to the short time period between carrying out the activity and reporting it. Trying to remember activities carried out in periods such as the previous week, month or year may be accompanied by errors.<sup>29</sup>

The LAF may assist in remembering the types of activities carried out, an important aspect in measuring the construct.<sup>3</sup> Sallis et al<sup>20</sup> (1993) compared four questionnaires aimed at nine-year-old children, with different formats. The questionnaire which did not contain a list of physical activities had the worst results for validity.

Dividing up the day is useful to avoid mistakes in remembering, as the physical activities are reported in a chronological order, and this helps organize the child's mental process and allows the activities carried out in that particular period to be remembered. Dividing the day according to school periods follows the natural organization of the children's daily activities.<sup>4</sup>

The LAF interview instructions served to orient the interviewer and are related to the homogenization of the interview proceedings, enabling systematic errors to be minimized.<sup>4</sup> They also help the children to understand

important concepts necessary for the interview and evaluate their notion of time. In this study, three children were excluded as they had a poor notion of the passage of time.

The compendium proposed by Ainsworth et al<sup>2</sup> (1993) was used to calculate the scores of physical activities (weighted and unweighted) as it had also been used in the original study and therefore enabled the values for validity of the two studies to be compared. This manual is specifically for the adult population. Ridley et al<sup>18</sup> (2008) published a compendium of physical activities specifically for children and adolescents. There is, however, a need for studies which adopt this proposal so as to reinforce the elements which favor its use.

Assessing the concurrent validity and operational equivalence of the LAF is part of the transcultural adaptation process of the Physical Activity Checklist Interview,<sup>21</sup> assessing aspects of conceptual and semantic equivalence of the items as well as reporting its reliability. The results complement the LAF transcultural adaptation process, which is a valid instrument for assessing physical activity in Brazilian children aged from seven to ten.

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The authors declare that there are no conflicts of interests.