



Reproducibility and validity of the International Physical Activity Questionnaire in adolescents

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ABSTRACT

The International Physical Activity Questionnaire (IPAQ) was originally developed to provide a self-report measure that can be used to obtain internationally comparable data on habitual physical activity. The objective of this study was to analyze the reproducibility and validity of IPAQ short form in a representative sample of adolescents. A total of 161 adolescents (92 girls and 69 boys) with ages between 12 and 18 years were included in the study. For the assessment of reproducibility, Spearman correlation coefficients and Bland-Altman plots were computed between administrations of the questionnaire at baseline, and after two weeks. Validity was determined by comparing questionnaire against a 24-hour recall instrument of the daily activities. Spearman correlation coefficients and proportion of agreement (Kappa values) were calculated, based on categorization of the distributions of the physical activity variables into quartiles. Results showed correlation coefficients ranging from 0.49 to 0.70 in girls and from 0.56 to 0.83 in boys, all statistically significant. Although these data are comparable to most other self-report reproducibility studies, Bland-Altman plots demonstrated limited concordance capacity between test-retest of the questionnaire. In terms of validity, the time spent in each activity reported in the IPAQ was modestly correlated with the 24-hour recall data (range 0.09-0.51). However, when the time spent in moderate and intense activities were reported, the validity indicators increased considerably, and the values observed were higher for older boys. In conclusion, these data provide evidence that, in adolescents of both genders and older than 14 years, the IPAQ have acceptable measurement properties for monitoring levels of habitual physical activity. Among younger adolescents (< 14 years old), findings indicate that the use of the IPAQ short form presents some limitations.

INTRODUCTION

The habitual practice of physical activities is characterized as a vital component for the establishment of a health ideal situation. In adults, clear evidences show that lower levels of physical activity are directly related with higher incidence of cardiovascular diseases, diabetes, hypertension, obesity, osteoporosis and some types of cancer⁽¹⁾. A meta-analysis involving more than 40 studies suggests that the cardiovascular diseases are 1.9 time more probably developed in less active subjects than in those physically active⁽²⁾. Among individuals with risk factors that predispose to chronic-degenerative dysfunction, the proportion of subjects usually classified as sedentary is significantly higher than the one of physically active⁽³⁾.

Although a low number of adolescents may come to present chronic-degenerative dysfunctions, recent studies indicate involvement in blood pressure, plasma lipid/lipoprotein and body fat indi-

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cators in this age range as result of the lower levels of physical activity practice⁽⁴⁾, and that, next, inactiveness will induce important metabolic and functional limitations at adulthood⁽⁵⁾. In the psycho-emotional field, higher levels of usual practice of physical activities are associated with the maintenance of the self-esteem and self-concept and with the improvement of the interpersonal relationship that may be projected to the adulthood⁽⁶⁾.

On the other hand, even admitting that the potential contribution of the usual practice of physical activities in relation to the protection and improvement of the health state is extremely more difficult to identify during adolescence, there are strong evidences that undesirable behaviors that could affect the better health state in the adulthood, such as the inadequate practice of physical exercises, may be established and incorporated during young ages⁽⁷⁾. Thus, it seems to be possible to admit the existence of evidences sufficiently convincing that the usual practice of physical activities should be encouraged during adolescence, not only in the search for a better health state in the present time, but also in the attempt of preparing young subjects for the regular practice of physical activities during the adulthood. Long-term consequences of the usual practice of physical activities during adolescence increases its importance in the public health field.

In this context, monitoring of the usual practice of physical activities levels in segments of the young population has become an important issue of interest and concern among health professionals. Despite the availability of several methods aimed at the follow-up of indicators associated to the practice of physical exercises, such as the doubled marked water, direct observation, movement sensors, heart rate and self-recall recording⁽⁸⁾, not all methods are suitable to be employed in analyses involving a large number of subjects. In these cases, the self-administered questionnaire regarding daily physical activities has been defined as an frequently recommended option for these types of analysis.

However, data regarding the usual practice of physical activities found by means of the questionnaires application may differ due to the nature and specifications of the questions presented, what probably will change according to gender, age, cognitive development, the sociocultural context the subjects are inserted on⁽⁹⁾, and the data treatment procedure aimed at the assessment of the energetic expenditure or the physical activity index. Therefore, previous to the application of a questionnaire, the analysis of indicators with regard to its validity and reproducibility becomes important specifically within the population it should be applied to.

With regard to the questionnaire options available for the evaluation of the usual practice of physical activities levels, in function of the evidences regarding the fulfillment of the standardization and practicality criteria, the International Physical Activity Questionnaire-IPAQ⁽¹⁰⁾ has more recently received special attention. However, although some studies have attempted to present evidences related to the validity and reproducibility of this questionnaire in the Brazilian adult population^(11,12), no studies with these characteristics involving segments of the young population were

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found so far. In this context, the objective of the present study was to analyze indicators associated to the concurrent validity and reproducibility by means of the International Physical Activity Questionnaire application in a representative sample of adolescents.

MATERIAL AND METHODS

Students regularly enrolled in three schools in the city of Londrina, Paraná, were selected for the elaboration of this study. These three schools were selected due to the similarity with regard to the administrative characteristics (junior and senior high schools from the public net), geographic localization (schools located at the central region of the city) that represent the socioeconomic profile of the students in the universe of schoolboys and schoolgirls who attend public schools in the city.

The procedures employed in the study were approved by the Ethics Committee in Researches of the Londrina State University and followed norms of the Resolution 196/96 of the National Health Council on researches involving human beings. The inclusion of subjects in the sample occurred for their own sake in participating in the study. Thus, students enrolled in the 7th, 8th, 9th, 10th and 11th grades who attended the schools selected were contacted and informed about the nature of the study, and were invited to participate in it. From the 230 schoolboys and schoolgirls initially interested in participating in the study, 69 of them did not fulfill all stages foreseen in the study's design, being therefore excluded from the definitive sample. Thus, the definitive sample was composed of 161 students from both genders with ages ranging from 12 and 18 years. For the analysis of information, considering the age range and the equivalent educational level of the subjects selected (junior and senior high school), the sample was divided into four groups: a) girls ≤ 14 years of age; b) girls > 14 years of age; c) boys ≤ 14 years of age and d) boys > 14 years of age. Table 1 presents information concerning the anthropometrical characteristics of the subjects involved in the study.

TABLE 1
Average values and standard deviation of the anthropometrical characteristics of the adolescents involved in this study

	Girls		Boys	
	≤ 14 years (n = 59)	> 14 years (n = 33)	≤ 14 years (n = 38)	> 14 years (n = 31)
Age (years)	12.92 ± 0.86	15.88 ± 0.93	13.00 ± 0.81	15.81 ± 0.70
Stature (cm)	158.27 ± 7.05	161.16 ± 5.54	162.17 ± 9.34	175.56 ± 8.59
Body weight (kg)	49.75 ± 8.34	55.54 ± 12.16	55.99 ± 15.14	65.63 ± 12.73
BMI (kg/m ²)	19.83 ± 2.93	21.30 ± 3.98	21.11 ± 4.92	21.42 ± 3.25

The IPAQ was proposed by the International Group for Consensus of Physical Activity Measurements under the seal of the World Health Organization with representatives of 25 countries, including Brazil. It deals about an instrument developed with the objective of estimating the habitual practice of physical activities of populations from different countries and sociocultural contexts⁽¹⁰⁾. The IPAQ is originally presented in different languages including Portuguese, what required no translation. Two IPAQ versions are available: a long and a short versions. Both versions present self-administered or telephone interview characteristics and search to provide information with regard to the walk frequency and duration, and daily activities that require physical efforts of moderate-high intensities, besides the time spent with activities performed in sitting position during days from the middle of the week (between Monday and Friday) and weekend (Saturday and Sunday), where a typical week or the last week was considered as the reference period. The short-form self-administered questionnaire was selected because this version is the most frequently suggested

for the use in young populations. This version is composed of eight open questions and its information allows to estimate the weekly time spent with different physical activities dimensions (walks and physical efforts of moderate-high intensities) and spent with physical inactivity (sitting position). To do so, the product between the duration (minutes/day) and frequency (days/week) reported by the adolescents in the responses of the questions presented in the IPAQ was performed.

For the IPAQ application, the adolescents were gathered in groups of 10-15 subjects in a classroom. The participants received the questionnaire with filling instructions and recommendations, and no time limit was given for the task, and eventual doubts were promptly explained by the professional in charge of the data collecting. During the questionnaire filling, the adolescents had no communication with each other, in the attempt of avoiding possible undesirable interferences in their responses.

The information on the questionnaire's reproducibility were obtained by means of a second application on the same subjects within a two-week interval using procedures identical to those adopted in the first application. Those adolescents who did not show up at the day and time scheduled for the questionnaire's reply filling were excluded from the study.

After filling the questionnaire reply, the participants received retrospective self-recall instrument of the daily activities recommended by Bouchard *et al.*⁽¹³⁾ (R-24h) with instructions and recommendations in order to identify and to record the type of activity performed along the day. In this case, the daily activities are classified into a *continuum* involving nine categories according to estimations concerning the average energy expenditure of activities performed by human beings: 1) rest in bed; 2) activities performed in sitting position; 3) light activities performed in standing position; 4) activities that require light walks (< 4 km/hour); 5) light manual work; 6) active leisure activities and practice of recreative sports; 7) moderate rhythm manual work; 8) active leisure activities and the practice of moderate-intensity exercise; and 9) intense manual work and the practice of competitive sport.

For the questionnaire's filling, the day was divided into 96 periods of 15 minutes each, and the participants identified the type of activity classified between categories from 1 to 9 performed in each period of 15 minutes during 24 hours. The roll of daily activities that correspond to activities performed in the different categories was presented to the adolescents in the attempt of facilitating the filling of the instrument. Moreover, the participants were instructed to perform additional notes in case some activity performed was not included in the roll specifically elaborated for this purpose.

With those informations, the time spent by each subject in the different physical activity categories was established. The time spent in categories 8 and 9 (average energetic cost > 6 METs) was considered as indicator of high-intensity physical activity. The time spent in categories 5, 6 and 7 (average energetic cost between 3.0 and 6.0 METs) was considered as indicator of moderate-intensity physical activity; the time spent in category 4, as indicator of walking, and category 2, as indicator of physical inactivity (sitting position). The retrospective instrument was filled in four days of the same week, two days from the middle of the week (between Monday and Friday) and two days from the weekend (Saturday and Sunday). For calculation purposes, the weighted average including the four days was used.

The statistical treatment was performed by means of the *Statistical Package for the Social Science* (SPSS) – version 12.0. For the analysis of information, the non-parametrical statistics resources were used, once the data presented did not show *normal* frequency distribution. The Kolmogorov-Smirnov test was used in order to check the frequency distribution. The descriptive statistics procedures were used for the characterization of the sample selected for the study and later the Kruskal-Wallis (K-W) analysis of variance

was used to compare the variables selected between gender and age group. Whenever significant, the analysis of variance was complemented by the Mann-Whitney test in order to identify specific differences. The significance level of 5% was adopted ($p < 0.05$). Informations with regard to questionnaire's reproducibility were analyzed by means of two procedures associated to the concordance index between measures replications: a) Spearman correlation coefficient (R_s) considering confidence intervals of 95%; and b) plotting in dispersion diagram according to technique developed by Bland and Altman⁽¹⁴⁾. With regard to the questionnaire's validity, two non-parametrical statistical procedures were used: a) Spearman correlation coefficient between the time spent in the physical activity indicators produced by the IPAQ and R-24h; and b) proportion of agreement (Kappa values) between categorizations according to the distribution of the physical activity variables into quartiles produced by IPAQ and R-24h.

RESULTS

Statistical information concerning the time spent in the different physical activities estimated by the IPAQ and R-24h are shown in table 2. When the K-W values produced by the analysis of variance involving data presented by both measure instruments are analyzed, one verifies that the time spent in activities involving high-intensity physical efforts presented statistical differences favorable to boys. With regard to the comparison between the other physical activity dimensions, no relevant statistical differences were found. Comparisons between both age groups considered revealed that, for both genders, the median of the time spent in higher or lower effort activities presents significant modifications with age. Younger boys and girls (≤ 14 years of age) tended to remain significantly less time in sitting position and more time performing activities involving high-intensity physical efforts in comparison with the older schoolmates (> 14 years of age). A large inter-individual variation with regard to the time spent in the four physical activity dimensions considered was also verified, as can be verified through the high values associated to the interquartile differences.

TABLE 2
Median values and interquartile differences (Q_3-Q_1) in relation to time (min/day) spent in different physical activity dimensions

	Girls		Boys	
	≤ 14 years (n = 59)	> 14 years (n = 33)	≤ 14 years (n = 38)	> 14 years (n = 31)
IPAQ				
Sitting position	300 (180)	450 (310)	260 (160)	430 (290)
Walks	360 (210)	310 (220)	350 (190)	340 (210)
Moderate efforts	410 (290)	340 (190)	390 (220)	380 (240)
Intense efforts	250 (160)	140 (110)	370 (210)	180 (110)
R-24h				
Sitting position	885 (435)	930 (600)	780 (420)	840 (555)
Walks	90 (60)	90 (45)	150 (105)	120 (75)
Moderate efforts	75 (45)	90 (45)	90 (60)	90 (60)
Intense efforts	45 (30)	30 (15)	90 (45)	60 (30)

The Spearman correlation coefficients associated to the time spent in physical activities reported by the adolescents in IPAQ questionnaire replies are in table 3. All values found presented statistical significance and demonstrated magnitudes between 0.49 and 0.83. When stratified by gender and age group, one observes that boys and older adolescents tended to present higher agreement rates between questionnaires. The specific analysis of the physical activity dimensions considered in the questionnaire reveals that the R_s values with regard to physical activities involving strong physical efforts were higher than in the other dimensions.

The capacity of the adolescents to report the time spent in walks and in activities involving moderate physical efforts were the physical activity dimensions presenting the lowest R_s values, but still demonstrating reasonable agreement between IPAQ questionnaire applications.

TABLE 3
Spearman correlation coefficients (R_s) and equivalent confidence intervals (95%) associated to time spent in physical activity dimensions reported by adolescents in IPAQ applications¹

	Girls		Boys	
	≤ 14 years	> 14 years	≤ 14 years	> 14 years
Sitting position	0.58 (0.54-0.61)	0.61 (0.58-0.65)	0.62 (0.57-0.68)	0.82 (0.79-0.84)
Walks	0.52 (0.47-0.55)	0.55 (0.51-0.58)	0.56 (0.51-0.60)	0.61 (0.57-0.67)
Moderate efforts	0.49 (0.45-0.55)	0.63 (0.60-0.65)	0.59 (0.55-0.65)	0.66 (0.62-0.71)
Intense efforts	0.55 (0.50-0.61)	0.70 (0.66-0.75)	0.67 (0.65-0.70)	0.83 (0.80-0.85)

¹ All R_s values are statistically significant ($p < 0.05$).

Figures 1 and 2 illustrate the dispersion diagrams with the plotting of the average values of the time spent in the physical activity indicators reported by adolescents in IPAQ questionnaire applications (abscissa) and the individual differences between both applications (ordinate). This analysis procedure proposed by Bland and Altman allows observing the average differences and the agreement outer limits (± 2 SD of the difference) presented by the questionnaire applications. The graphic arrangement of data suggests a higher variability between girls, in younger age groups and in the time spent in walks and in moderate-intensity physical activities. However, the older adolescents presented relevant coincidences between the questionnaire applications, above all with regard to the activities performed in sitting position and with the involvement of high-intensity efforts. The average differences and the concordance limits ranged from 16 ± 92 min (boys > 14 years, sitting position) to 131 ± 429 min (girls ≤ 14 years, moderate-intensity physical activities).

TABLE 4
Statistical indicators associated to the validity of information from IPAQ and R-24h reported by adolescents

	Sitting position	Walks	Moderate physical efforts	Intense physical efforts
Girls ≤ 14 years				
R_s (95% IC)	0.13 (0.09-0.16)	0.17 (0.14-0.21)	0.24 (0.21-0.28)	0.26 (0.22-0.31)
Kappa	0.06	0.13	0.09	0.09
Concordance (%)	21.6	24.3	32.4	18.9
Girls > 14 years				
R_s (95% IC)	0.24 (0.19-0.30)	0.11 (0.08-0.15)	0.35 (0.31-0.40)*	0.43 (0.38-0.47)*
Kappa	0.06	0.09	0.19	0.11
Concordance (%)	29.6	18.5	40.7	33.5
Boys ≤ 14 years				
R_s (95% IC)	0.29 (0.25-0.32)	0.09 (0.06-0.11)	0.29 (0.25-0.32)	0.35 (0.31-0.38)
Kappa	0.01	0.07	0.07	0.37
Concordance (%)	26.7	20.1	53.4	54.3
Boys > 14 years				
R_s (95% IC)	0.39 (0.36-0.42)	0.12 (0.09-0.15)	0.34 (0.30-0.37)*	0.51 (0.47-0.55)*
Kappa	0.10	0.05	0.19	0.24
Concordance (%)	32.2	21.4	39.3	42.8

* Statistically significant ($p < 0.05$).

Table 4 shows the statistical indicators related to the validity of information found in IPAQ in relation to R-24h. Information considering gender and age group with regard to the Spearman correlation coefficients between the time spent in the physical activity dimensions estimated by means of both measure instruments reveal low-to-moderate magnitude values. Only among adolescents

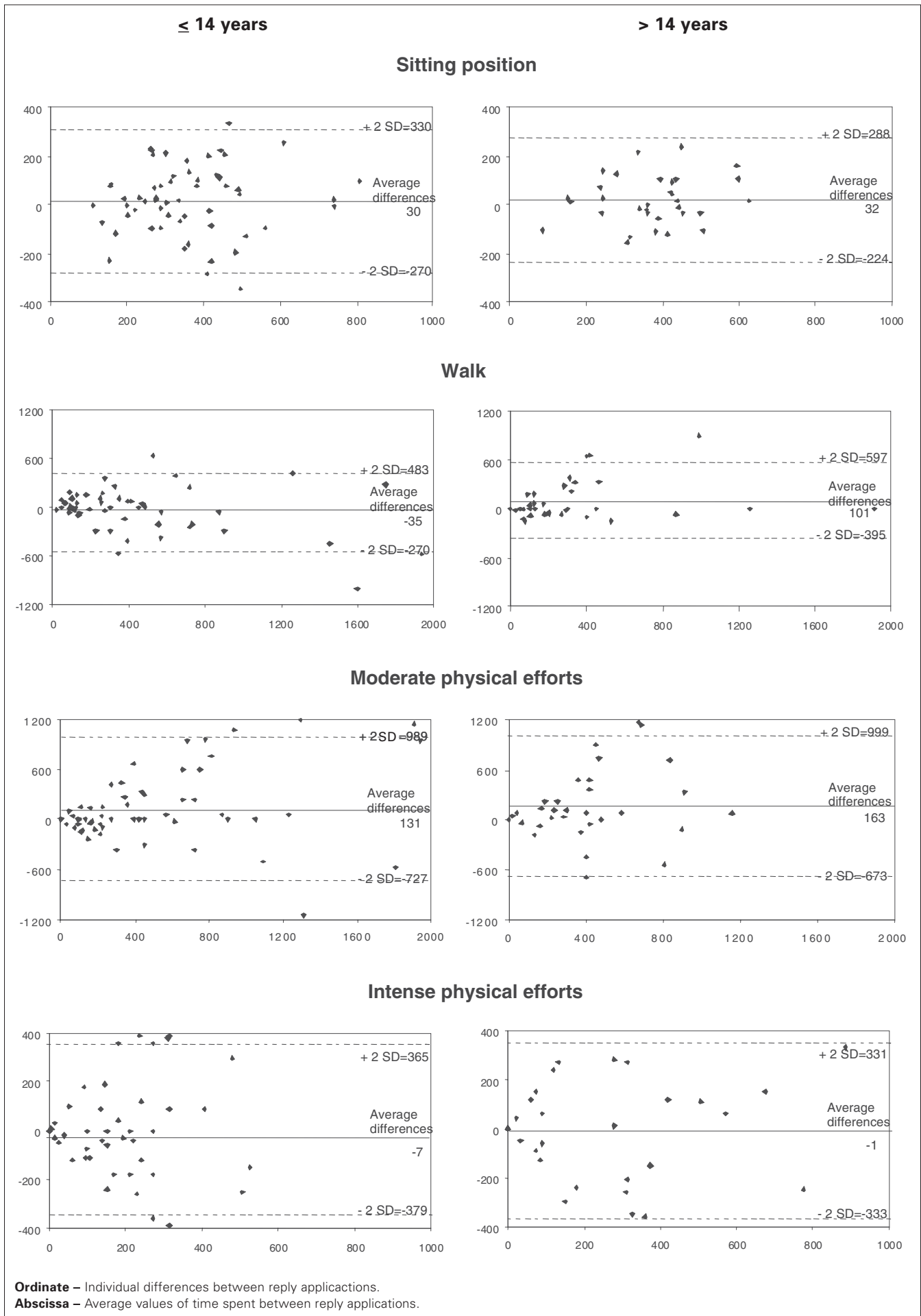


Fig. 1 – Bland-Altman procedure in relation to the concordance limits between IPAQ questionnaire applications in adolescents – Girls

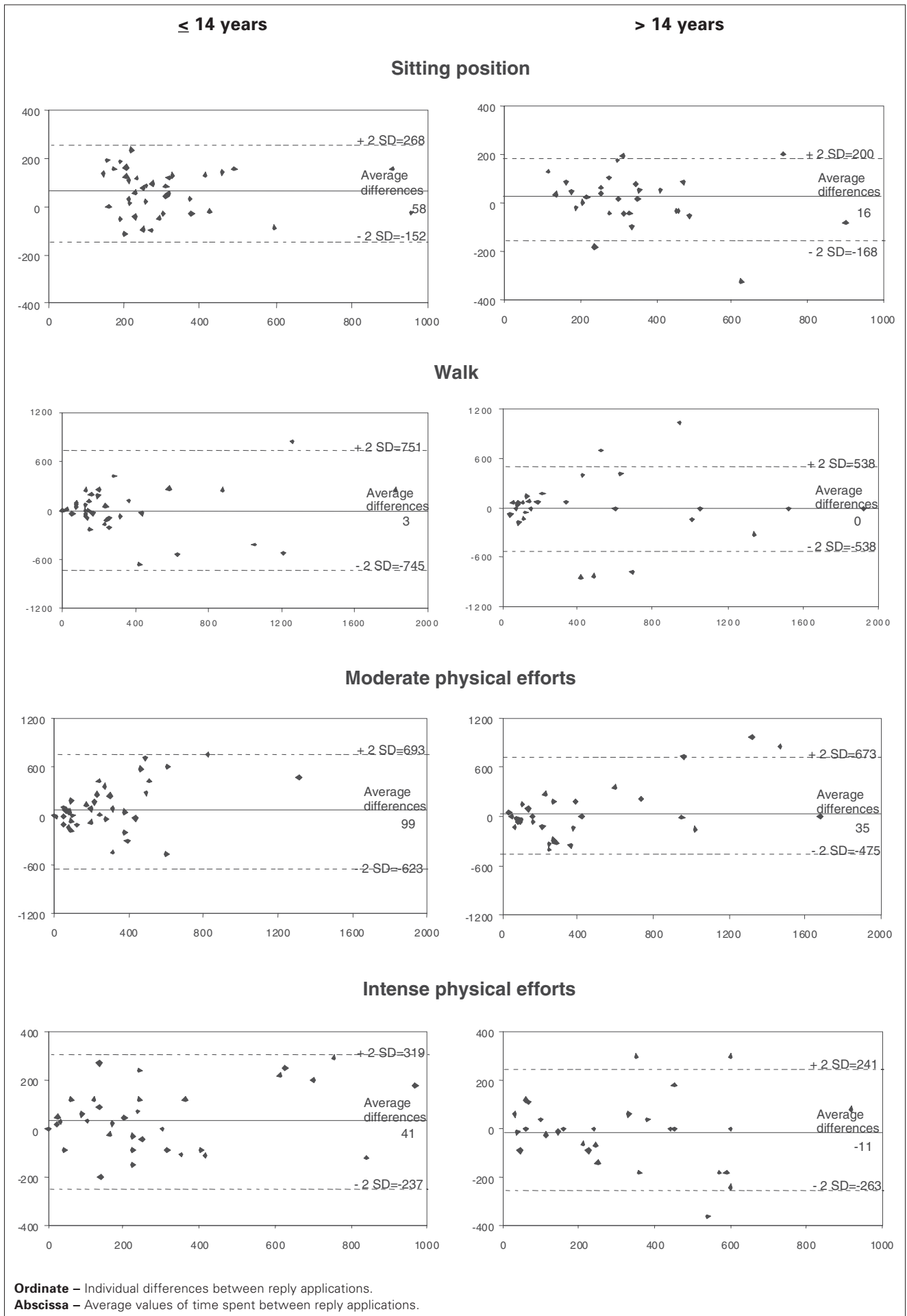


Fig. 2 – Bland-Altman procedure in relation to the concordance limits between IPAQ questionnaire applications in adolescents – Boys

older than 14 years of age and in physical activity dimensions involving moderate and high intensity efforts, R_s values with statistical significance are found. In the other cases, the correlation coefficients were found below 0.39 ($p < 0.089$). Similar results are observed in relation to the Kappa coefficients. In this case, values statistically significant are only found associated to the time spent in physical activities involving high-intensity efforts among boys. According to criterion suggested by Landis and Koch⁽¹⁵⁾, the Kappa values that presented statistical significance in the present study suggest a low-to-moderate magnitude validity. With relation to the concordance proportion, the highest values were found among boys and in information with regard to the time spent in moderate and intense physical activities.

DISCUSSION

Questionnaires represent the most accessible instrument for the usual physical activity evaluation, above all in epidemiological nature studies due to the easiness of being applied to large groups, low cost and for allowing collecting information with relation to the type and context in which they are performed, what does not occur to other measurement resources. However, for the account of the characteristics of information to be observed, questionnaires may present inconsistencies in the responses, and, when compared to other measurement resources, they demonstrate more difficulty to fulfill the criteria associated to the reproducibility and validity of their results. To our knowledge, this seems to be the first study aimed at analyzing the IPAQ validity and reproducibility in adolescents.

When the information associated to the average time spent in the four physical activity dimensions reported by the adolescents through IPAQ and R-24h are analyzed, one verifies that the found results corroborate data presented in other studies^(16,17), indicating boys as habitually more active than girls, and decline tendency on the habitual practice of physical activities levels during adolescence. However, when the information presented by both measurement instruments are compared, one verifies that through the IPAQ, the adolescents tended to report shorter time spent in activities performed in sitting position as well as longer time spent in activities involving walks and moderate and high intensity physical efforts. These informations confirm evidences available in literature that report that young individuals, when evaluated through questionnaires, tend to present higher predisposition in reporting levels of physical activity practice higher than they actually are⁽¹⁸⁾.

The reproducibility of the questionnaire in the present study was analyzed through two statistical procedures: Spearman correlation coefficient and plotting in dispersion diagrams according to the Bland and Altman technique. Regarding the Spearman correlation coefficients, one verifies that the R_s found values presented similar statistical significance and magnitude to those obtained by other studies available in literature involving different types of questionnaires aimed at evaluating physical activity in adolescents⁽¹⁹⁻²¹⁾. Furthermore, one also verifies that the reproducibility capacity found in IPAQ applied to adolescents in the present study is slightly smaller than that found in IPAQ applied in adult subjects⁽¹⁰⁻¹²⁾.

An important study conducted by Craig *et al.*⁽¹⁰⁾ gathered results of the IPAQ reproducibility found in samples of adults selected from populations of 12 different countries. The Spearman correlation coefficient values observed ranged from 0.32 (South Africa rural region) to 0.88 (United States), with a pool R_s of 0.76. Yet, 75% of the R_s found results presented magnitudes above 0.65, what allows the IPAQ-short version to provide information associated to the usual practice of physical activities with reproducibility similar to other's questionnaires. As illustration, in a review study involving seven questionnaires with those characteristics, R_s values between 0.34 and 0.89 were found in adults from both genders⁽²¹⁾.

On the other hand, analyzing additional information with regard to the IPAQ reproducibility by means of the statistical technique proposed by Bland and Altman, one verified that the concordance capacity between questionnaire applications may be impaired. In this context, it seems that, for the account of the statistical presupposition involved in their calculation procedures, the Bland and Altman technique shall present higher sensitiveness in the detection of differences between measurements when compared to conventional analyses involving non-parametrical statistical resources, in this case, the Spearman correlation coefficient. In theory, one admits that systematic differences eventually detected between measurements should not affect the magnitude of any correlation coefficient; however, they could restrict significantly the concordance degree between both measurements⁽²²⁾, what may be confirmed through the analysis performed by means of the technique suggested by Bland and Altman.

In the present study, for the reproducibility analysis by means of the plotting technique suggested by Bland and Altman, dispersion diagrams were constructed, where the average difference between the IPAQ questionnaires and the distribution of individual differences within a 2-SD confidence interval was taken into consideration. Thus, one expects that, when the questionnaire is applied in two moments to the same adolescents in similar situations, the average differences between questionnaire applications should approximate to value zero and the extreme limits of the confidence intervals are found the closest as possible to values equivalent to the average differences.

However, when observing information available in figures 1 and 2, if on the one hand one observes that the dimensions of the usual practice of physical activities considered in the IPAQ (sitting position, walks, moderate and intense physical efforts) present average values between questionnaire applications close to zero, on the other, distances between the extreme limits of the confidence intervals that may cause concern are verified.

In order to illustrate that situation and considering specifically the case of physical activities reported by adolescents older than 14 years of age involving intense physical efforts, the average differences observed between both questionnaire applications were of only 1 and 11 min/day in girls and boys, respectively. Considering the magnitude of median values found in this group of adolescents (140 and 180 min/day for girls and boys, respectively), one may speculate that, on average, the differences between information presented by adolescents with regard to the questionnaire application were quite discreet, in other words, between 1.5 and 5%.

However, the extreme limits of the confidence intervals (± 2 SD) were established between 331 and -333 min/day for girls and 241 and -263 min/day for boys, what reveals a quite high individual variability with regard to the questionnaire application. Statistically, these information indicate that, in 95% of cases, a given girl or boy older than 14 years of age may report, by means of the IPAQ application, time spent with physical activities involving intense physical efforts with differences of approximately 330 and 250 min/day, respectively. Even before these evidences, one suggests caution in the interpretation of the amplitude observed between the extreme limits of the confidence intervals, considering the reduced number of subjects involved in the present study and the occurrence of some outlier cases in the arrangement of the dispersion diagram values.

In relation to the validation indicators, the selection of a reference method to serve as comparison becomes vital for the analysis of information, considering that it shall represent the true measure of the physical activity practice with the most accuracy as possible. In this context, the resources involving the doubled marked water are recognized as the most accurate for the estimation of the energetic expenditure/day and hence as the most indicated reference method to provide information about the valida-

tion of questionnaires aimed at the evaluation of the habitual practice of physical activity level⁽⁸⁾. However, the operational difficulties of the procedures and the high cost of the laboratorial tests that this method requires makes its utilization unfeasible in researches involving a higher number of individuals. Thus, the R-24h of daily activities proposed by Bouchard *et al.*⁽¹³⁾ was employed as reference method in the present study, because this method depends only on the memory of the subject evaluated and provides detailed information with regard to the activities performed along each day, classified into nine categories according to the type and intensity of the physical efforts performed.

The statistical indicators related to the validity found among girls and boys older than 14 years of age here analyzed are close to tendencies observed in studies available in literature involving the IPAQ application in adult subjects⁽¹⁰⁻¹²⁾, and are consistent with information from other proposals of questionnaires aimed at the evaluation of the habitual physical activity in adolescents^(19,20). However, when considering information associated to girls and boys younger than 14 years of age, one verifies that the R_s and the Kappa values found in the present study presented no statistical significance and lower magnitude than those presented by other studies involving different questionnaire proposals and information from the R-24h instrument^(23,24).

In this study, the format of the IPAQ questionnaire employed requires the appraised subject to determine the duration (min/day) and frequency (days/week) of attributes associated to the usual practice of physical activity performed in the last week. Thus, considering that the recall capacity and the stability on the performance of some daily activities become more sensitive and improved along the years in childhood and adolescence⁽²⁵⁾, one expects that the older adolescents come to present higher concordance between information presented through IPAQ and R-24h. These evidences reinforce the hypothesis suggested by Trost *et al.*⁽²⁶⁾, that age and gender information are some of the features to be considered in the selection and application of questionnaires aimed at the evaluation of the usual practice of physical activities.

In relation to the validation indicatives associated to the four physical activity dimensions specifically, for both genders and age groups considered, the IPAQ questionnaire demonstrated lower validity in relation to the R-24h questionnaire with regard to information on the time spent in activities performed in sitting position and in walks. Probably, this might have occurred because these activities are quite common in the daily life of adolescents; therefore, the time spent with these activities is long, but intermittently distributed in short periods along the whole day. In this context, the adolescents may have presented difficulties in dimensioning more precisely the effective time spent in activities with these characteristics and, therefore, the concordance capacity between information obtained through IPAQ and R-24 h is impaired.

On the other hand, information regarding time spent in activities involving intense physical efforts presented the highest associations between IPAQ and R-24h. This fact may be justified because this type of physical activity, besides requiring a shorter time in the adolescents' daily activities, is performed in a defined and so important period of time that the adolescent could easily remember, therefore presenting higher discriminatory capacity in relation to the other physical activity dimensions, what facilitates its identification and increases substantially the magnitude of the statistical indicators employed in the validation analysis.

CONCLUSIONS

Based on results found in the present study, one may infer that, by means of the IPAQ application, the time spent in the four physical activity dimensions reported by adolescents does not necessarily reveal its actual measure. When the IPAQ questionnaire is compared with the R-24h questionnaire, the adolescents tended

to underestimate the time spent in activities performed in sitting position and to overestimate the time spent in activities involving walks and moderate and intense physical efforts. However, in relation to the reproducibility of information presented by the adolescents, more conservative statistical indicators suggest that the considered IPAQ version has satisfactory concordance capacity between applications, corroborating results presented by other studies available in literature reporting that the reproducibility of information associated to physical activities involving moderate and intense physical efforts is higher than that of information associated to the other physical activity dimensions. On the other hand, considering an apparent higher sensitive statistical resource in the detection of differences between the questionnaire applications, one verifies some limitations with regard to the IPAQ potential to follow the habitual practice of physical activities in adolescents.

In relation to the statistical indicators associated to the validation, although the criterion instrument adopted for this analysis may not be considered as *gold standard*, statistical information selected in this study indicate that, among adolescents older than 14 years of age (> 14 years), the IPAQ may be defined as a suitable instrument aimed at the follow-up of physical activities involving moderate and intense physical efforts. However, the lowest associations observed between information presented by the adolescents by means of the IPAQ and R-24h with relation to activities performed in sitting position and walks indicate the need to establish adjustments in specific issues of the IPAQ with regard to these physical activity dimensions with the objective of improving its validation indicators. In younger adolescents (\leq 14 years of age), the IPAQ questionnaire did not fulfill the validation criteria proposed, what counter-indicates its application in this population segment.

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