

Research article

A physical activity questionnaire: Reproducibility and validity

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Abstract

This study evaluates the Quantification de L'Activite Physique en Altitude chez les Enfants (QAPACE) supervised self-administered questionnaire reproducibility and validity on the estimation of the mean daily energy expenditure (DEE) on Bogotá's schoolchildren. The comprehension was assessed on 324 students, whereas the reproducibility was studied on a different random sample of 162 who were exposed twice to it. Reproducibility was assessed using both the Bland-Altman plot and the intra-class correlation coefficient (ICC). The validity was studied in a sample of 18 girls and 18 boys randomly selected, which completed the test – re-test study. The DEE derived from the questionnaire was compared with the laboratory measurement results of the peak oxygen uptake (Peak VO₂) from ergo-spirometry and Leger Test. The reproducibility ICC was 0.96 (95% C.I. 0.95-0.97); by age categories 8-10, 0.94 (0.89-0.97); 11-13, 0.98 (0.96- 0.99); 14-16, 0.95 (0.91-0.98). The ICC between mean TEE as estimated by the questionnaire and the direct and indirect Peak VO₂ was 0.76 (0.66) (p<0.01); by age categories, 8-10, 11-13, and 14-16 were 0.89 (0.87), 0.76 (0.78) and 0.88 (0.80) respectively. The QAPACE questionnaire is reproducible and valid for estimating PA and showed a high correlation with the Peak VO₂ uptake.

Key words: Physical activity, questionnaire, validity, children, adolescents.

Introduction

The increase in physical activity (PA) in young ages could prevent or delay the onset of adult pathological states (Pols et al., 1997). PA can be objectively measured by different methods some of which require special equipment and are not very well adapted to a large sample study of children. Questionnaires, interviews and diaries represent subjective methods for estimating PA, which are usually preferred in epidemiological studies.

Objective methods for measuring PA combine video, movement's counters, accelerometer, heart rate monitoring, blood pressure monitoring, electromyography, anthropometry, fitness, VO₂ metabolic cart or VO₂ portable equipment, respiration chamber and doubly labelled water (DLW). However, they require special equipment and are not very well adapted to a large sample study of children.

Questionnaires, interviews and diaries represent subjective methods for estimating PA, which are usually preferred in epidemiological studies. A supervised self-

administered questionnaire appeared as the most feasible and economically appropriate approach to address the specific objective of the Bogotá study. However, a PA questionnaire must fulfill the following criteria i) *non-reactiveness*, i.e. it does not alter the behavior of the study population; ii) *practicability*; iii) *applicability*, i.e. it is particularly designed to suit the population; and iv) *accuracy*, i.e. it is reliable and valid (Caspersen et al., 1998). An activity questionnaire is valid when it is able to rank individuals or groups of subjects within a population from the least to the most active, with a good correlation with relevant physiologic parameters or disease outcomes (Kriska and Caspersen, 1997). Little is known about PA in Latin American children thus an epidemiological study was launched by the El Bosque University (COL) and Paris Descartes University (FRA) to evaluate PA in youngsters in Bogotá.

Questionnaires for quantification of PA are strongly dependent on the notion of "compendium of PA" (Ainsworth et al., 2000), which allows for an estimation of the total energy expenditure as a summation of specific activities defined by their intensity and duration and expressed in metabolic equivalents (Mets) in relation to body mass.

Many questionnaires have shown good reliability in adults (Ainsworth et al., 2000; Friedenreich et al., 1998), but, for youngsters some of the validity correlations were non significant or low (Sallis et al, 2000). In the literature, the measurements derived from PA questionnaires in adults have been usually compared either with a direct PA assessment like self- report logging procedures, heart rate monitoring and accelerometers, or with indirect indicators like maximal aerobic capacity, dietary intake or percent body fat (Booth et al., 2002; Philippaerts and Lefevre, 1998; Rauh et al., 1992; Washburn et al., 2003).

The maximal oxygen uptake is often commonly used for validation purposes, although the functional capacity is influenced by age, gender, altitude and other factors. The measurement of maximal oxygen uptake is chosen because of its biological proxy of physical activity (Saris, 1996) and has been measured using two methods previously used in validity studies (Booth et al., 2002, Washburn et al., 2003).

Therefore, the aim of the study was to develop a specific questionnaire, the QAPACE (Quantification de l'Activite Physique en Altitude Chez le Enfants) and to

assess the reproducibility and validity of this questionnaire.

Methods

The Paris Descartes University (Paris, France) approved the design, while the Secretaría de Educación de Bogotá, the application. None of the schools refused to participate and informed consent was requested from all students and their parents.

The proposed questionnaire

Different questionnaires have been developed for measuring PA (Aaron et al., 1993; 1995; Bouchard et al., 1983; Kriska, 1997). QAPACE (see Appendix), is self-administered and supervised and 18 questions were developed according to 13 categories (Table 1) of daily physical activities, covering all the possible school or vacation activities of the youth over the past year.

Construction of the questionnaire

Several questionnaires and methods were developed until the best ways of approach and introduction in a school were found. Volunteers from among the senior physicians, belonging to the permanent staff of the departments of either Community Medicine or Pediatrics or Sport Medicine from the El Bosque University were invited to participate in a course on the QAPACE study during a full week. During this course, each participant was requested to ask young relatives to test the questionnaire and to bring their comments back. Future supervisors were selected from this group. The latter were secondarily instructed, trained and motivated during a three-day workshop devoted to the management of the questions on the questionnaire by the pupils and to the means for minimizing biases in the questionnaire. The supervisors received specific training for assisting the children and giving them a proper understanding of the questions in the questionnaire for minimizing biases. They were particularly instructed on how to read out loud and explain the written foreword comment of the questionnaire about the specific meaning of an average day when answering the different items.

Three schools were randomly selected from among

the 460 schools of Bogotá not participating in a planned future bigger survey, urban co-ed regular diurnal schools, with both elementary and secondary grades, and with a physical educator, one from each from high, middle and low socio-economic strata, a formal written acceptance by the parents, students and administrative staff of the school was requested. The acceptance criteria were: 1) 8-16 yr old; 2) born and living in Bogotá; 3) healthy, without disabilities; 4) non pregnant. Six students were randomly selected in each of the nine age groups (8-16 yr) for each gender. Hence, a total of $3 \times 6 \times 9 \times 2 = 324$ children were exposed to the initial version.

The students were invited in groups of 10-15 to receive instructions on how to identify only the activities they had participated in on at least ten occasions over the last year, and to complete the questionnaire. For each of those activities they had to specify the corresponding estimated average duration of each session in hours and minutes per day and the frequency of these sessions expressed in days per week. The questionnaires were collected and checked for inconsistencies. Less than 40 minutes were necessary to complete them.

The reproducibility

Three schools were selected from among the remaining 457 schools. Three students were randomly selected for each of the schools, nine grades and two genders, totalizing 162 students. Out of the randomly selected sample of 162 children, only 121 were included; 41 were not included due to non compliance of the criteria. All the 121 subjects filled the same questionnaire 90 days later (McDowell, 1987).

At the time of the surveys, the students were weighed in light clothing on a calibrated platform (Seca Digital Floor Scales - Model 7700). Height was measured to the nearest 0.1cm using a free standing Holtain Anthropometer. All data was stored in a Visual FoxPro 6.0 database.

Estimation of the energy expenditure using the questionnaire

The Daily Energy Expenditure (DEE), for school and vacation, along with the PA compendium (Ainsworth et al., 2000) were used to obtain the annual mean DEE.

Table 1. Categories of physical activity with their corresponding items in the QAPACE questionnaire.

Category	Questions	Description
1	1	Sleeping
2	2, 3	Toilet including bathing, dressing & undressing
3	4, 5, 6	Meals (eating)
4	7, 8	Transportation (walking, riding by car, busing, cycling, motorcycling, roller-skating)
5	9, 10	Classroom (sitting in class, home work, etc)
6	11	Mandatory physical education
7	12	Other activities in school: artistic (music, dancing, theater, arts, etc), craft activities and additional sports of leisure.
8	13	Out of school activities: miscellaneous and leisure sports (deskwork, TV watching, videogames, Music listening, reading, leisure sport activities, etc)
9	14	Religious activities
10	15	As item 8 but during vacation time
11	16	Personal artistic activities not associated with school
12	17	Sport competition and training
13	18	Home activities: sweeping, mopping, cleaning, washing, laundry, ironing, cooking, child care, gardening, etc.

Table 2. Comprehension and Test re-test study: description of the anthropometric variables, expressed as mean (\pm standard deviation), according to the different age groups in the sample of 324 children and adolescents (Comprehension study) and 121 children and adolescents (Test re-Test study) randomly selected from the population-based cohort provided by the Secretaría de Educación de Bogotá (Bogotá's Education Secretary), 2001-2002.

	Comprehension Study (8-10 yr)	Test re-test Study (8-10 yr)	Comprehension Study (11-13 yr)	Test re-test Study (11-13 yr)	Comprehension Study (14-16 yr)	Test re-test Study (14-16 yr)
N	108	41	108	40	108	40
Age (yr)	9.1 (.8)	9.1 (.8)	12.1 (.8)	12.1 (.8)	15.0 (.8)	15.0 (.8)
Height (m)	1.36 (.08)	1.35 (.07)	1.53 (.07)	1.52 (.07)	1.61 (.07)	1.61 (.08)
Weight (kg)	29.8 (5.1)	29.4 (4.8)	41.5 (7.5)	40.7 (8.0)	53.2 (7.6)	52.7 (7.9)
BMI (kg·m ⁻²)	16.2 (2.0)	16.0 (2.0)	17.7 (3.0)	17.5 (2.8)	20.4 (2.9)	20.5 (2.8)

$$DEE = \sum_{i=1}^{i=13} (((f_{sp}(i) \cdot d_{sp}(i) \cdot 280) + (f_{vp}(i) \cdot d_{vp}(i) \cdot 85)) / 365) m(i))$$

The sum is extended over all possible activities i ($i=1$ to 13). For each activity i ($i=1$ to 13), $f(i)$ corresponds to its daily frequency, $d(i)$ to its mean duration and $m(i)$ to its intensity according to the compendium. SP corresponds to School period and VP corresponds to Vacation period.

Validation methods

The direct and indirect peak VO_2 methods were used on 36 subjects from the reliability study who were randomly selected and whose results were plotted with the Bland-Altman method.

The measurements of oxygen uptake

Indirect method: aerobic fitness

The peak VO_2 was assessed using the Lèger Test. In compliance with the protocol, the laps were counted. Stage and level were converted into peak VO_2 mL·kg⁻¹·min⁻¹, using the following formula (Leger and Lambert, 1982):

$$\text{Peak } VO_2 = 31.025 + 3.238 * \text{speed (km} \cdot \text{h}^{-1}) - 3.248 * \text{age (y)} + 0.1536 * \text{speed (km} \cdot \text{h}^{-1}) * \text{age (y)}$$

Direct method: ergo-spirometry

The Hebestreit protocol was used (Heberstreit et al., 2000) on a calibrated cycle ergometer (ER900 Jaeger, Würzburg, Germany). The work rate was initially set up to 0 W·kg⁻¹ body mass for 2 minutes, and then increased every 2 min by 1 W·kg⁻¹ body mass. After a total of three 2 min-stages, including the initial stage, work rate was

Table 3. Test-retest study: Intra class correlation coefficients between two estimations of total energy expenditure measured at two different times, 6 weeks apart, over one year period in the random sample of 121 young students from Bogotá, 2001-2002.

Categories	N	Intra-class correlation coefficient [95% CI]
All	121	.96 [.95 ; .97]
Age (years)		
8-10	41	.94 [.89 ; .97]
11-13	40	.98 [.96 ; .99]
14-16	40	.95 [.91 ; .98]
Gender		
Male	56	.98 [.96 ; .99]
Female	65	.95 [.91 ; .97]
School grade		
Elementary School	41	.98 [.97 ; .99]
Secondary School	80	.94 [.91 ; .96]
Period activities		
Vacation period	121	.97 [.96 ; .98]
School period	121	.96 [.94 ; .97]
Socio-economic strata (see map)		
1-2	46	.94 [.90 ; .97]
3-4	40	.98 [.96 ; .99]
5-6	35	.99 [.97 ; .99]
Activities		
1- Sleeping	121	.93 [.91 ; .95]
2- Toilet	121	.90 [.87 ; .93]
3- Meals	121	.97 [.96 ; .98]
4- Transportation	121	.84 [.78 ; .89]
5- Classroom	121	.97 [.96 ; .98]
6- Mandatory physical education	121	.95 [.93 ; .97]
7- Other activities in school	121	.94 [.92 ; .96]
8- Out school activities	121	.96 [.94 ; .97]
9- Religious activities	121	.93 [.90 ; .95]
10- Vacations	121	.97 [.96 ; .98]
11- Personal artistic activities	121	.98 [.97 ; .99]
12- Sport competition	121	.98 [.97 ; .99]
13- Home activities	121	.89 [.85 ; .92]

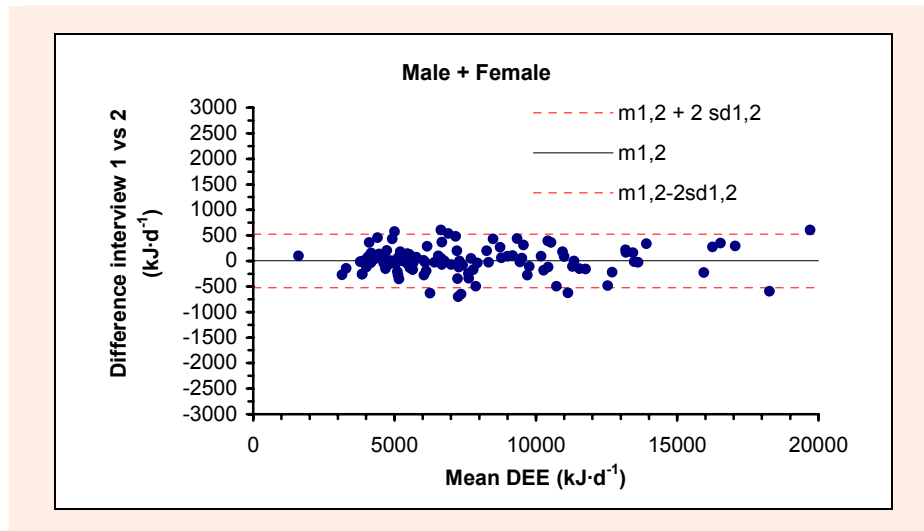


Figure 1. Test re-test study: Bland & Altman plot of the difference of the daily energy expenditure estimates between the test-retest periods versus their corresponding mean in the whole sample.

increased every min by $0.5 \text{ W}\cdot\text{kg}^{-1}$ until exhaustion. The peak oxygen uptake, expressed in $\text{mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$, was determined from expired air sampled at 30 seconds intervals using an Oxycon Delta Jaeger. The measured outcomes were the averaged cardiac frequency (CF) over the duration of the experiment ($\text{beats}\cdot\text{min}^{-1}$), the respiratory-quotient (RQ), the Minute Respiratory Volume (MRV) both at the maximal load, and the peak VO_2 . The values of the peak VO_2 were secondarily converted into $\text{kJ}\cdot\text{kg}^{-1}\cdot\text{h}^{-1}$ using $1 \text{ Met} = 4.184 \text{ kJ}\cdot\text{kg}^{-1}\cdot\text{h}^{-1} = 1 \text{ kcal} = 0.207 \text{ L of O}_2$ [Ainsworth et al, 2000,].

Statistical analysis

Means and standard deviations were used for both the test-retest reproducibility between the two periods, and also the Validity study, using Pearson's ICC with its 95% confidence interval (SPSS 11.0 statistical Software, Chi, Ill) and the Bland & Altman plot (Bland et al., 1986). For validation, two methods were used for, 1) the concordance between direct and indirect peak VO_2 , and 2) the concordance between direct or indirect peak VO_2 and the DEE over a one year period.

Results

Study 1: Questionnaire comprehension

Between August 2001 and October 2001 the comprehension study was undertaken with a sample of the 324 remaining students, i.e. 162 boys and 162 girls, aged 8-16 years (Table 2).

It was necessary to modify Distance and Mode of Transportation and Sports, and, "Child care" was added to home activities, because among girls from low income families, this activity is common (Table 1).

Study 2: Test re-test study

The study was carried out from February to March 2002. The time needed for each session was shortened to 30 minutes average for all age groups. A general description of the study sample of the 121 is given in Table 2. The ICC of the group sorted by age, grade, gender, etc. is in Table 3. The corresponding Bland & Altman DEE plots are shown in Figures 1, 2 and 3. The first one corresponds to the total population. The lower and upper limits of two standard deviations below and above the mean difference

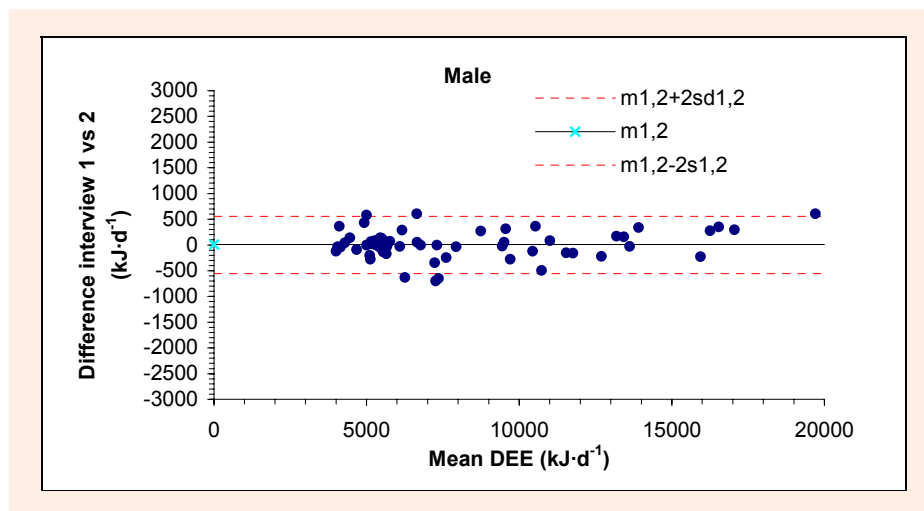


Figure 2. Test-retest study: Bland & Altman plot of the difference of the daily energy expenditure estimates versus their corresponding mean in the sample restricted to boys.

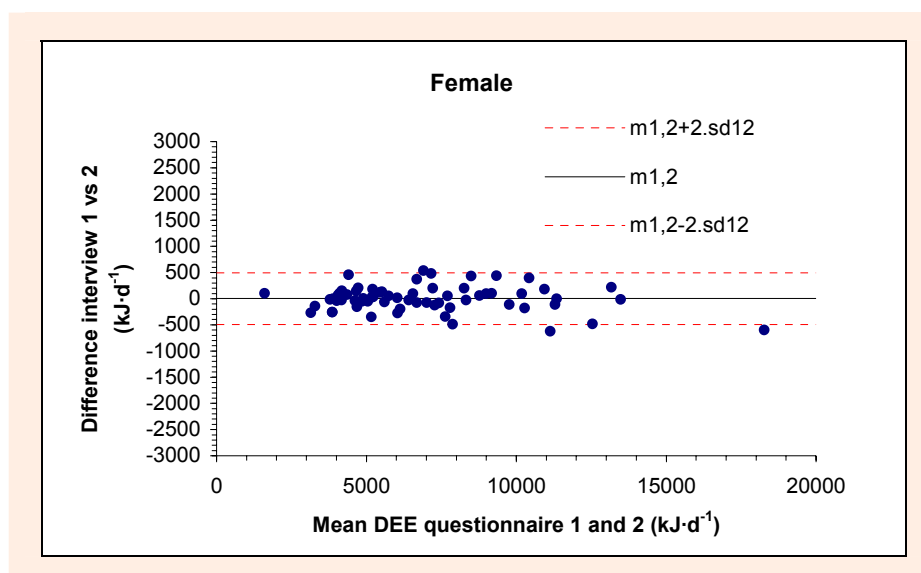


Figure 3. Test-retest study: Bland & Altman plot of the difference of the daily energy expenditure estimates versus their corresponding mean in the sample restricted to girls.

(8.5 kJ) were -515.5 and 532.5 $\text{kJ}\cdot 24^{-1}$ hours. The mean absolute EE of the two questionnaires was 7566 $\text{kJ}\cdot \text{d}^{-1}$ (SD 3521). In boys (Figure 2), the mean difference was 10.8 with lower and upper limits of -546.2 and 567.8 $\text{kJ}\cdot 24^{-1}$ hours. Whereas in girls (Figure 3), the mean difference was 4.5 with lower and upper limits of -487.5 and 496.5 .

In order to estimate the variability capacity of the DEE according to the daily activities as recorded by the questionnaire, the mean durations for each of the thirteen categories of activities are shown (Table 4).

In Table 4, the categories 1-3, 9, 11-13 correspond to rather stable activities all year around, whereas the categories 4-7 and 8 correspond to stable activities during the school period. In the 7×24 hours = 168 hours of a school or vacation week, a mean of 157 (93.5 %) and

145.2 (86.4 %) hours/week, respectively, correspond to routinely fixed activities, leaving only 6.4% and 22.8 %, for variability in physical activities during the periods.

It can be noted that the highest correlation correspond to the rather fixed activities (Table 4: activities 1-3 and 5-12), whereas the lowest ones correspond to more variable activities (Distance and mode of Transportation and Home Activities).

Study 3: Validation study

The mean values of the observed CF, RQ and MRV suggest the rather good quality of the load reached by the students during the peak VO_2 Test.

The overall mean DEE was 125.7 (SD 24.9) $\text{kJ}\cdot \text{kg}^{-1}\cdot \text{min}^{-1}$, whereas it was 135.5 (SD 28.8) (boys) and 115.9 (SD 15.6) (girls). The mean values of DEE were higher in

Table 4. Mean (SD) durations of the different categories of PA during one representative week during school and the vacation periods as measured in a random sample of children and adolescents from 8 to 16 years of age in Bogotá. NA: non applicable.

Category	Questions	Description	School period (Hours/week)	Vacation period (Hours/week)
1	1	Sleeping:	56.0 (7.0)	56.0 (7.0)
2	2, 3	Toilet including bathing, dressing & undressing	2.7 (1.75)	2.7 (1.75)
3	4, 5, 6	Meals (eating): 3 meals	7.8 (1.4)	7.8 (1.4)
4	7, 8	Transportation (to and from) - Walking - Riding by car or by bus - Other (cycling, motorcycling, roller- skating, etc)	4.2 (.33) 1.5 (.25)	NA
		Global	5.8 (.37)	
5	9, 10	Classroom activities + homework	42.5 (5.0)	NA
6	11	Mandatory physical education	3.0 (1.0)	NA
7	12	Other activities in school: artistic (music, dancing, theater, arts, etc), craft activities and additional sports of leisure.	2.5 (.75)	NA
8	13	Out school activities: miscellaneous activities (deskwork, TV watching, videogames, Music listening, reading and leisure sport activities, etc)	17.5 (.5)	NA
9	14	Religious activities	.75 (.25)	.75 (.25)
10	15	Idem 8 but during vacation time	NA	59.5 (7.0)
11	16	Personal artistic activities not associated with school	2.0 (.5)	2.0 (.5)
12	17	Sport competition and training (rare in our students)	9.0 (6.0)	9.0 (6.0)
13	18	Home activities sweeping, mopping, cleaning, washing laundry, ironing, cooking, child care, gardening, etc.	7.5 (.75)	7.5 (.75)

Table 5. Descriptive statistic for the total sample and by gender. Data are means (\pm SD).

Variable	All (N = 36)	Males (N = 18)	Females (N = 18)
Age (yr)	12.0 (2.6)	12.0 (2.7)	12.0 (2.7)
Weight (kg)	41.9 (12.4)	42.7 (16.3)	41.2 (6.9)
Height (m)	1.42 (.14)	1.42 (.16)	1.42 (.12)
Indirect peak VO ₂ (mL·kg ⁻¹ ·min ⁻¹)	42.7 (6.0)	46.2 (5.9)	39.1 (3.6)
Peak VO ₂ mL·kg ⁻¹ ·min ⁻¹)	44.5 (8.7)	49.9 (7.7)	39.2 (5.8)
Max. Heart Rate (beats·min ⁻¹)	186.7 (9.9)	188.6 (8.3)	184.8 (11.1)
Respiratory Quotient	1.00 (.07)	1.02 (.08)	1.00 (.06)
Minute Respiratory Volume (L·min ⁻¹)	66.7 (17.9)	73.4 (20.3)	60.0 (12.1)
DEE school period (kJ·kg ⁻¹ ·day ⁻¹)	133.3 (26.1)	143.7 (30.0)	123.0 (16.4)
DEE vacation period (kJ·kg ⁻¹ ·day ⁻¹)	100.4 (25.6)	108.4 (28.7)	92.5 (18.2)
DEE total year- period (kJ·kg ⁻¹ ·day ⁻¹)	125.7 (24.9)	135.5 (28.8)	115.9 (15.6)

boys than in girls, whether they were considered over one year or separately over the school or vacation periods (Table 5).

The relationship between the direct and indirect measurements of peak VO₂ is shown on Figure 4. The general ICC is 0.91 ($p < 0.01$), whereas it was 0.96 (boys) and 0.67 (girls).

The ICC between the indirect measurement of VO₂ uptake and the overall mean DEE was 0.56 ($p < 0.0001$). The corresponding ICC between direct measurement of peak VO₂ and the respective mean DEE was 0.69 ($p < 0.00001$). The ICC remained high for both school and vacation. They were lower in the female group as compared with the male group (Table 6), and increased with age category. The Bland-Altman plot between the DEE and the direct and indirect peak VO₂ are shown in Figures 5 and 6.

Discussion

The aim of the present study was to assess the reproducibility and validity of the QAPACE questionnaire in a random sample of children attending school in the city of Bogotá, as a preliminary step for a large-scale study aiming to evaluate PA in the corresponding population. The 30 min average time needed to fill the questionnaire

doesn't exceed the mental concentration capacity of youngsters and has showed a high reproducibility, although the youngest subjects used more time completing the questionnaire.

Generally, children are unable to estimate accurately the duration of an activity. For them, intensity and enjoyment are directly tied to the duration of any activity. To make things easier for the subjects, especially for the youngest ones, different specific periods of time (15 min, 30 min, 45 min, 60+ min) were offered, so as to improve the accuracy while completing the questionnaire [Montoye, 1996].

The questionnaire was designed to measure the mean DEE over the past year, during school and vacation, 24 hours a day. We believe that the repeated previous comprehension tests, the presence of a supervisor, the limited size of the group with the possibility of answering to their questions could explain the high reproducibility. The delay of 6 weeks between the two test-retest sessions could have been too short to detect changes in activities. The six weeks detainment between the test-retest was reported to represent the minimal time for a subject to forget the previous responses (McDowell, 1987). The delays in the studies reported in the literature can be 10 days (Vuillemin et al., 2000), 15 days (Booth et al., 2001), one month (Aaron et al., 1993), 3 months (Aaron et al.,

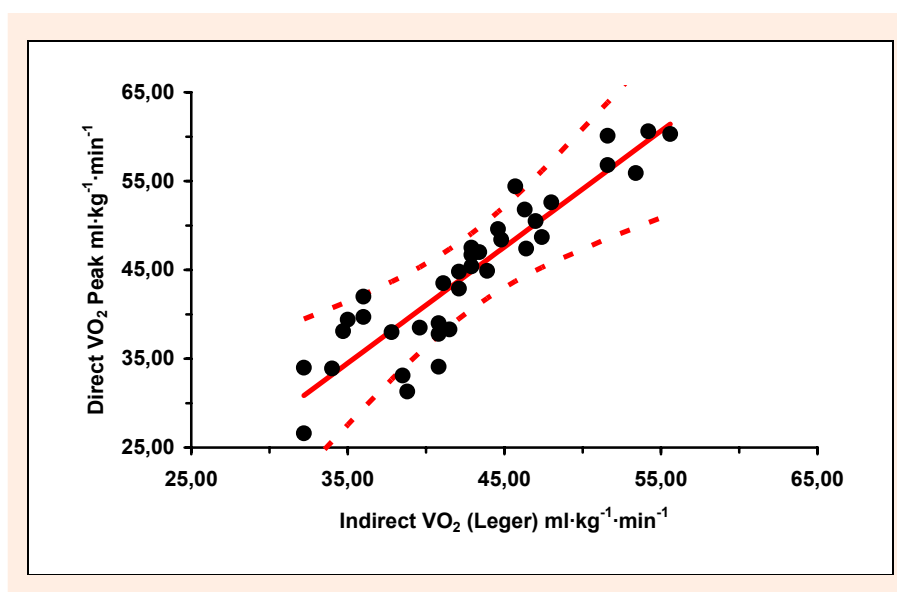


Figure 4. Correlation between Direct and Indirect VO₂ (Lèger test).

Table 6. Pearson interclass correlation coefficient (ICC) and the corresponding 95% confidence interval (95% CI) between energy expenditure either during school, vacation and whole year periods and both the indirect and direct peak VO₂ measurements, by gender and group ages.

	Indirect VO ₂		Direct VO ₂	
	ICC	95% CI	ICC	95% CI
All (N =36)				
School period (280 days) (kJ·kg ⁻¹ ·day ⁻¹)	.54 **	.26-.74	.67 **	.43-.82
Vacations period (85 days) (kJ·kg ⁻¹ ·day ⁻¹)	.52 **	.23-.72	.64 **	.40-.80
12- month period (kJ·kg ⁻¹ ·day ⁻¹)	.56 **	.28-.75	.69 **	.40-.80
Males (N =18)				
School period (280 days) (kJ·kg ⁻¹ ·day ⁻¹)	.43 *	-.04-.75	.59 **	.18-.83
Vacations period (85 days) (kJ·kg ⁻¹ ·day ⁻¹)	.46 *	-.01-.76	.63 **	.23-.85
12- month period (kJ·kg ⁻¹ ·day ⁻¹)	.45 *	-.01-.76	.63 **	.22-.84
Females (N =18)				
School period (280 days) (kJ·kg ⁻¹ ·day ⁻¹)	.34	-.15-.69	.57 **	.14-.82
Vacations period (85 days) (kJ·kg ⁻¹ ·day ⁻¹)	.37	-.11-.71	.55 **	.11-.81
12- month period (kJ·kg ⁻¹ ·day ⁻¹)	.37	-.12-.71	.61 **	.18-.83
(8-10 years) (N =12)				
School period (280 days) (kJ·kg ⁻¹ ·day ⁻¹)	.44 *	-.18-.81	.64 **	.10-.89
Vacations period (85 days) (kJ·kg ⁻¹ ·day ⁻¹)	.39 **	-.23-.79	.57 *	.00-.86
12- month period (kJ·kg ⁻¹ ·day ⁻¹)	.44*	-.18-.81	.64 **	.10-.89
(11-13 years) (N =12)				
School period (280 days) (kJ·kg ⁻¹ ·day ⁻¹)	.71 **	.23-.91	.69 **	.20-.91
Vacations period (85 days) (kJ·kg ⁻¹ ·day ⁻¹)	.78 *	.36-.93	.78 **	.38-.94
12- month period (kJ·kg ⁻¹ ·day ⁻¹)	.78 **	.36-.93	.76 **	.34-.93
(14-16 years) (N =12)				
School period (280 days) (kJ·kg ⁻¹ ·day ⁻¹)	.82 **	.46-.95	.89 **	.64-.97
Vacations period (85 days) (kJ·kg ⁻¹ ·day ⁻¹)	.73 **	.28-.95	.78 **	.38-.94
12- month period (kJ·kg ⁻¹ ·day ⁻¹)	.82 **	.47-.95	.89 **	.64-.97

* p < 0.05 ; ** p < 0.01

1995; Berthouze et al., 1993), 6 months (Pols et al., 1997) or one year (Aaron et al., 1995).

It has been reported that surveys focusing on a one year time frame are more likely to reflect usual activity patterns than those recording activities over a few days or

over the past week (Kriska and Caspersen, 1997).

The ICC was lower, in the youngest and oldest groups, which could correspond to ages with less concentration or unstable behavior. The ICC were higher in children from higher socio-economic status and for the

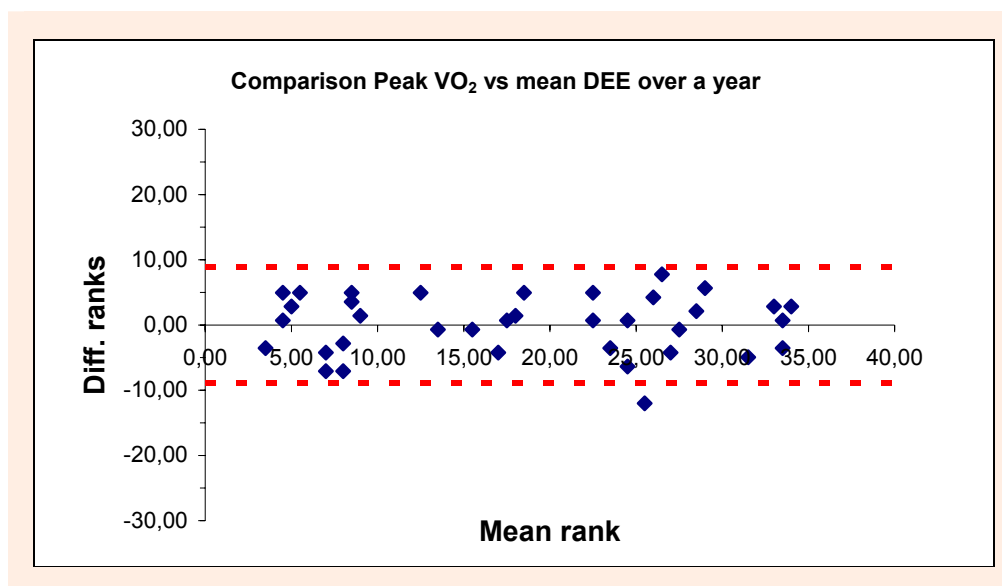


Figure 5. Bland-Altman plot showing the relationship of the mean daily energy expenditure and peak VO₂ in all subjects based on the respective ranks of the corresponding values of the direct VO₂ and the mean DEE.

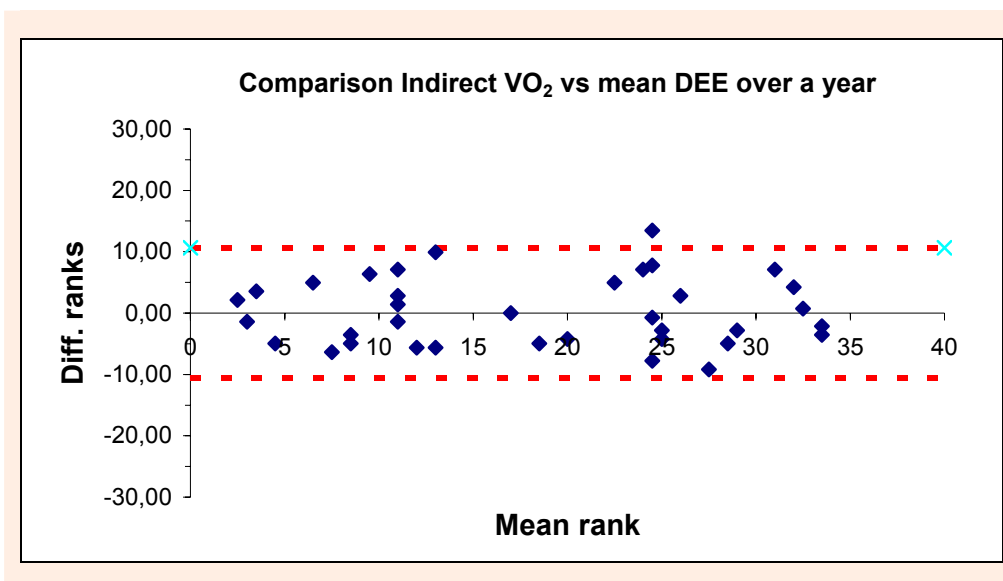


Figure 6. Bland-Altman plot showing the relationship of the mean daily energy expenditure and indirect VO_2 in all subjects, based on the respective ranks of the corresponding values of the indirect VO_2 and the mean DEE.

categories corresponding to a personal choice like artistic activities, sport competition and vacation whereas they were lower for home activities or transportation, corresponding to mandatory or uncomfortable activities.

Few studies have examined the reproducibility and validity of a questionnaire in children on the yearly PA using a self-administered but supervised modality. Thus, direct comparisons with other studies differing in test instrument, population and time frame should remain cautious. Nevertheless, the reproducibility coefficients were comparable to the ones reported with respect to the different test-retest time intervals. The studies in children show ICC between 0.66 and 0.98 with time intervals between 6 days and 1 year (Aaron et al., 1995; Baecke et al., 1982; Berthouze et al., 1993; Bouchard et al., 1983; Garcia et al., 1997; Kowalski et al., 1997; Pols et al., 1997; Sallis et al., 1993, Taylor et al., 1978; Weston et al., 1997).

In adults, the following ICCs were reported as: 0.91 (6-10 days) (Bouchard et al., 1983), 0.89 (1 month) and 0.69 (1 year) (Taylor et al., 1978), 0.89 (1 month) and 0.79 (11 months) (Baecke et al., 1982), 0.997 (7 days) (Berthouze et al., 1993), 0.83 (95% C.I. 0.66- 0.99) (10 days) (Vuillemin et al., 2000). In a self-administered survey using 1 day PA recall questionnaire concerning 90 American teenagers from 7th to 8th grades (mean age 14 years), the ICC was in the range 0.98 to 0.99 using the heart rate method, Caltrac and pedometer measurements of 0.43, 0.77 and 0.88 (Weston et al., 1997).

When the CAINM questionnaire was applied to a Spanish speaking population of school children from Mexico City (Hernandez et al., 2000), both the children and their mothers were tested six months apart on the children activities and the results were compared. The correlation coefficients, adjusted on age, gender and socio-economic level, ranged between 0.09 and 0.55. This study dealt mainly with low socio-economic population.

The capacity of extrapolating the results of the reproducibility study to a large survey relies on the modalities of selection of the sample of schoolchildren. In the Validity study a significant correlation between the esti-

mated global DEE and both the indirect peak VO_2 measurement (Leger test) and the direct peak VO_2 measurement were found.

The lower ICC observed in girls could be explained either by a different body composition between girls and boys with a higher fat mass in the former and a higher lean mass in the latter. This difference in mass conveys that the subjects with higher lean mass present a greater capacity for effort expressed in peak VO_2 and strength, and a lower motivation for physical activity in teenage girls (Aaron et al., 1993, Cooper, 1996). The measurements of peak VO_2 were lower in girls, by 23% in direct measurements and 17% in indirect measurements, all differences previously reported in the literature (Flandrois et al., 1982; MacMurray et al., 1998; Turley et al., 1997).

The global intra-class correlation coefficients (ICC) for the global measurements of PA showed a high ICC $r = 0.96$ (95% CI 0.95-0.97). The few studies which have been published addressing, specifically the validity of a self-administered but supervised questionnaire, aimed to estimate a mean PA index in children over the past year; therefore, direct comparisons with other studies differing in test instruments, the population studied, the time frame and the geographical location should remain cautious.

However, the ICC reported here appears comparable to the ICC of the Bouchard three day- questionnaire with PWC 150 or PWC 50/kg of respectively 0.70 and 0.27 (Bouchard et al., 1983) for a recalled period covering the last six to ten days; They are also comparable to the values of the ICC reported in other studies: 0.47 - 0.82 in a seven day recall questionnaire with the heart rate as the biological measurement (Sallis et al., 1993); 0.40 in children 4- 8 years, with the Estonian Questionnaire of the parents and their children and the heart rate (Harro, 1997); 0.38 for 7-9 years gymnasts; 0.42 for recreational in prepubertal girls with a 7 day- delay questionnaire and the Caltrac accelerometer in Scerpella et al. (2002). Also for a seven day recall questionnaire adapted to children with max VO_2 as the biological measurement in Schmucker (Schmucker et al., 1985) the ICC was 0.67; 0.40 for boys

and 0.23 for girls using a seven day recall questionnaire adapted to children and submaximal VO_2 in cycle ergometer as the biological measurement in Suter (1993).

The correlations between the direct and indirect measurements of peak VO_2 were similar to the values reported by McNaughton. ($r = 0.87$) (McNaughton et al., 1996) or Van Mechelen ($r = 0.76$) (Van Mechelen et al., 1986).

Conclusion

To our knowledge, no study has directly addressed the issue of estimating a yearly average PA including school and vacation periods. The majority of available data on the validity of PA questionnaires in children concerned short-term (one, three, seven days) or mid-term (months) recall of physical activities. The QAPACE questionnaire is valid for assessing the routine PA patterns of children and adolescents in the tested sample. As it was randomly selected through a two step procedure in the population of schoolchildren of Bogotá, the QAPACE questionnaire proved its reliability and accuracy for epidemiological study and the possibility to be used in large population studies.

Acknowledgments

The authors thank all those who participated in the study, Oded Bar-Or; Laurence Joubin, Colette Moreel, Necker Hospital, Paris; Diana Gavassa, José Chaar, Germán García; Efraim Patiño, Jesús Reyes and Edgar Rodríguez; Alirio Rodríguez, from El Bosque University; Secretaría de Educación de Bogotá and Aide au Développement de la Médecine du Sport, France.

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Key points

- The presence of a supervisor, the limited size of the group with the possibility of answering to their questions could explain the high reproducibility for this questionnaire.
- No study in the literature had directly addressed the issue of estimating a yearly average PA including school and vacation period.
- A two step procedure, in the population of schoolchildren of Bogotá, gives confidence in the use of the QAPACE questionnaire in a large epidemiological survey in related populations.

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APPENDIX
(QAPACE, Quantification de l'Activite Physique en Altitude Chez le Enfants)

GENERAL INFORMATION ABOUT YOU

School:					(*)Code:	
Name of the Student:					(*)Code:	
Address:					Phone:	
Date of Survey	Grade	Sex	Date of Birth	Age	Weight	Height
dd mm yy	---	F M	dd mm yy	years	kg	cm mm

DAILY ACTIVITIES

Category 1: SLEEPING

1. How many average hours do you sleep?
 5 6 7 8 9 10+

Category 2: TOILET

2. How many average minutes do you spend in toilet (dressing and undressing, and showering)?
 15 30 45 60+
3. How many average minutes do you spend making the bed?
 15 30 45 60+

Category 3: MEALS

4. How many average minutes do you spend having breakfast?
 15 30 45 60+
5. How many average minutes do you spend having lunch?
 15 30 45 60+
6. How many average minutes do you spend having dinner?
 15 30 45 60+

Category 4: TRANSPORTATION

7. How many average minutes do you spend going home to school?
 5 15 30 45 60 75 90+
8. What kind of transportation do you use?
 Walking car bus bicycle motto skates other
- Which other? _____

SCHOOL ACTIVITIES

Category 5: CLASSROOM

9. How many class hours do you have in classroom?
 5 6 7 8+
10. How many average hours, do you spend studying or doing homework at home?
 15 30 45 60 75 90 120+

Category 6: MANDATORY PHYSICAL EDUCATION

11. How many physical education hours do you have in a week?
 1 2 3 4+

Category 9: RELIGIOUS ACTIVITIES

14. What religious activities do you do? For how long? How many times a week?

	Duration by session (min)						Weekly Frequency							
attending a ceremony	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	30	45	60	75	90	120+	1	2	3	4	5	6	7	
chorus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	30	45	60	75	90	120+	1	2	3	4	5	6	7	
Assistant (altar boy)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	30	45	60	75	90	120+	1	2	3	4	5	6	7	
Playing a musical instrument	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	30	45	60	75	90	120+	1	2	3	4	5	6	7	
Which instrument?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
	G	P	F	B	T	O								

Category 10: VACATION ACTIVITIES

15. What activities do you do in vacation period? For how long? How many times a week?

	Duration by session (min)						Weekly Frequency								
Watch T.V.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		
	30	45	60	75	90	120+	1	2	3	4	5	6	7		
Videogames/Internet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		
	30	45	60	75	90	120+	1	2	3	4	5	6	7		
Listening music	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		
	30	45	60	75	90	120+	1	2	3	4	5	6	7		
Reading	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		
	30	45	60	75	90	120+	1	2	3	4	5	6	7		
Sports	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		
	30	45	60	75	90	120+	1	2	3	4	5	6	7		
Which Sports?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
	CA	F	B	V	CI	CO	P	N	O						
Other activity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		
	30	45	60	75	90	120+	1	2	3	4	5	6	7		
Which one? _____															

Category 11: ARTISTIC ACTIVITIES

16. Which artistic activities, do you do out of school? For how long? How many times a week?

	Duration by session (min)						Weekly Frequency						
Singing, chorus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	30	45	60	75	90	120+	1	2	3	4	5	6	7
Guitar	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	30	45	60	75	90	120+	1	2	3	4	5	6	7
Piano/Organ	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	30	45	60	75	90	120+	1	2	3	4	5	6	7
Drums	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	30	45	60	75	90	120+	1	2	3	4	5	6	7
Flute	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	30	45	60	75	90	120+	1	2	3	4	5	6	7
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	30	45	60	75	90	120+	1	2	3	4	5	6	7
Which one? _____													

Category 12: COMPETITION SPORTS

17. What sport do you practice competitively? For how long? How many times a week?

	Duration by session (Hours)				Weekly Frequency							
Football	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	1	2	3	4	1	2	3	4	5	6	7	
Basketball	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	1	2	3	4	1	2	3	4	5	6	7	
Volleyball	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	1	2	3	4	1	2	3	4	5	6	7	
Bicycling	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	1	2	3	4	1	2	3	4	5	6	7	
Swimming	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	1	2	3	4	1	2	3	4	5	6	7	
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	1	2	3	4	1	2	3	4	5	6	7	

Which one? _____

Category 13: DOMESTIC ACTIVITIES IN HOME

18. What chores do you do at home? For how long? How many times a week?

	Duration by session (min)							Weekly Frequency							
Sweeping floors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	15	30	45	60	75	90	120+	1	2	3	4	5	6	7	
Vacuuming	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	15	30	45	60	75	90	120+	1	2	3	4	5	6	7	
Washing clothes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	15	30	45	60	75	90	120+	1	2	3	4	5	6	7	
Washing dishes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	15	30	45	60	75	90	120+	1	2	3	4	5	6	7	
Cooking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	15	30	45	60	75	90	120+	1	2	3	4	5	6	7	
Ironing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	15	30	45	60	75	90	120+	1	2	3	4	5	6	7	
Child care	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	15	30	45	60	75	90	120+	1	2	3	4	5	6	7	
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	15	30	45	60	75	90	120+	1	2	3	4	5	6	7	

Which one? _____

PLEASE DO NOT WRITE IN THIS AREA

Supervisor: _____ Code: _____ Phone: _____
 Address: _____ e-mail: _____

SUPERVISOR NOTES: