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A NEW INSTRUMENT FOR EVALUATING PHYSICAL ACTIVITY OF YOUNG PEOPLE: CONCURRENT VALIDITY AND RELIABILITY OF PHYSICAL ACTIVITY AND LIFESTYLE QUESTIONNAIRE (PALQ).

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Abstract - The aim of this study was to determine the concurrent validity and reliability of the Physical Activity and Lifestyle Questionnaire (PALQ) for adolescents, a self-report instrument designed to measure physical activity in Greek youth. Subjects were students (N=40) aged 13,65 (SD=0.9). Test-retest reliability was reported as the intra class correlation coefficient between estimated individual scores (METs) determined from two administrations completed within one-week period. Two evaluators using the same scoring protocol determined inter-observer reliability. Concurrent validity was assessed using two questionnaires (The"Three-day physical activity record" and The four by one-day recall physical activity questionnaire") and the CSA (model 7164) accelerometer as criterion standard. Results of this study indicated that reliability measured by intra class and inter-observer correlation coefficients was 0.772 and 1.0 respectively ($p<.05$). The rank correlation between the PALQ scores (METs) and i) the first questionnaire (Kcal) was 0.554 ($p<.001$), ii) the second questionnaire (METs) was .791 ($p<.001$), and iii) the CSA (counts) was .627 ($p<.001$). The results of this study supported the concurrent validity and the reliability of the PALQ as a measure of physical activity level for secondary school students in Greece. We would like to thank the students who were the subjects in this study for their patience and the parents for their undivided help.

Key words - questionnaire, concurrent validity, reliability, physical activity, CSA

Physical activity appears to have a pervasive effect on health among adults and children. However, nowadays inactivity in developed countries is taking an epidemic form for all age groups (Johnson & Deshpande, 2000). The participation of young people in physical activities decreases gradually (Armstrong, 1998) and there are some indications that this sedentary behavior is more likely to be carried on into adulthood (Janz, Dawson & Mohoney, 1999). These last years the health authorities of developed countries have attempted to implement intervention programs promoting an active lifestyle and positive health behaviors (Baranowski, Anderson & Carmack, 1998).

The development of reliable and valid instruments evaluating physical activity would significantly contribute to a better understanding of the relation mainly between physical activity and health as well as the implementation of effective intervention programs (NIH, 1996). The available methods of measuring physical activity include observation, motion sensors and heart rate monitors, isotope of *doubly labeled water*, estimation of energy expenditure, proxy reports as well as several self administered methods as the questionnaire and the daily diary (Montoye, Kemper, Saris & Washburn, 1996). However, the creation of reliable and valid instruments remains a critical scientific concern, especially where the evaluation of young people's physical activity is concerned (Pratt, Macera & Blanton, 1999).

Since every method has both advantages and disadvantages, the choice depends on the goals and objectives set for each study. The questionnaire has significant advantages over other methods since it is relatively inexpensive and at present it is the only method feasible for large population studies. However the majority of the well-known and widely used questionnaires has been constructed for specific research objectives and has been structured in a way that meets the specific socio-cultural characteristics encountered in each case. Also some of the available instruments have not yet been comprehensively evaluated as far as their validity and reliability are concerned providing therefore inaccurate and misleading conclusions (Montoye, Kemper, Saris & Washburn, 1996).

The most significant problem in constructing a valid instrument for evaluating physical activity is the absence of a reliable criterion against which all questionnaires would be compared (Aaron, Kriska, Dearwater, Cauley, Metz & LaPorte, 1995). Given this weakness the effort to validate a physical activity questionnaire involves the examination of its concurrent validity, which is the degree of accordance with the other widely used and acknowledged physical activity measures. Therefore, when different methods of measuring physical activity are compared with each other it is expected that they will give similar results when they measure the same behavior. This compatibility must be present when the comparison is made between questionnaires

(subjective method of estimating physical activity) (Kowalski, Croker & Faulkner, 1997) or between questionnaires and objective measures of estimating physical activity (Matthews & Freedson, 1995).

THE „PHYSICAL ACTIVITY AND LIFESTYLE QUESTIONNAIRE" (PALQ)

The PALQ is a new instrument to estimate physical activity and its creation served two purposes. The first one was to provide a well-controlled instrument for estimating students' physical activity levels to the researchers and the physical educators of our country and at the same time to take into account the educational and socio-cultural characteristics of Greek students. The second reason involved the specific demands of a large school intervention program titled "Sports Education and Health" that took place in 15 Greek public elementary and secondary schools.

General Characteristics: The PALQ addresses 11-18 year old students and is divided into two parts. Participation in activities during free time is being evaluated in the first part of the questionnaire. The participant is asked to check the frequency with which he/she participates in any of the 27 activities listed in this first part. The questions cover a broad range of social, academic, functional, recreational and sport activities that youngsters are typically involved. The answer for every activity-question should be given in the form of a 5 point scale that ranges from "never' (score: 1) to "almost daily" (score 5). The formation of this activity list was based on a questionnaire used during a European study funded by *International Council of Sports Science and Physical Education* (Pieron & Ledent, 1997). Following three pilot studies the activities included in the list were differentiated in order to match the cultural elements of our country and according to the age of the participants.

The participation in physical and sporting activities during the last seven days was evaluated through the second part of the questionnaire. This evaluation deals with a) transportation, b) participation in physical activity and sports at school, c) participation in recreational physical activities, d) participation in sport clubs/fitness centers during leisure time after school, and e) participation in physical activities and sport during weekends. The questionnaire was designed for large population studies and may be answered in 15-25 min depending on the subjects' age. This new questionnaire meets the standards that should characterize an advanced self-report instrument since it: a) evaluates all the dimensions of physical activity, b) classifies participants objectively, c) divides the day into parts facilitating thus the recall of information, d) includes specific administrative procedure, and e) coding procedures and statistical analysis are easy to be performed (Cale, 1994).

adults (ICC = 0.86 - 0.95, $p < 0.01$) and its validity has been also reported for children ($r = 0.80$, $p<0.01$) and adults ($r = 0.54$, $p < 0.01$) (Bouchard et al., 1983).

c) The four by one-day recall physical activity questionnaire) (4-1DRPAQ)

This interviewer administered self-report measure was designed for children aged 11 years and older and is used to gather four days of activity information (2 school days and two weekend days). It consists of two forms: school day and weekend day, the form is segmented into parts: morning, afternoon and evening and contains checklists of activities. The questionnaire measures four dimensions of physical activity: a) physical activity at school, b) sport at school, c) physical activity during leisure time and d) sport during leisure time. Additionally the questionnaire provides an objective scoring system and measure of physical activity in terms of: a) average daily energy expenditure (Kcal·kg-1·day-1), b) time spent on moderate physical activity, c) time spent on hard and very hard activity and d) bouts of "huff" and "puff" activity. The final score assigns the responder to one of the following categories: very inactive, inactive, moderately active and active. The reliability and validity of this questionnaire have been tested for 11 to 14 year-old children and have been reported as $r = 0.62$ ($p < 0.05$) (reliability) and $r = 0.61$ ($p < 0.01$) (validity) (Cale, 1994).

Selection of questionnaires used in this study – Pilot studies

The researchers adapted the 3DPAR and the 4-1DRPAQ questionnaires in order to use them with Greek high school children since both questionnaires have been reported as validated and reliable instruments in studies assessing physical activity in children. The three questionnaires used in this study assess physical activity by estimating energy expenditure either in METs or in Kcal. Additionally, the content and the format of the questions included in 3DPAR and 4-1DRPAQ was modified to be relevant to the cultural characteristics of Greek children. The adaptation from English to Greek language did not require any changes in either the number or meaning of the questions (both questionnaires). The 4-1DRPAQ uses the Compendium of Physical Activities (Ainsworth et al., 2000), which is also used by PALQ. Standard methods were used to translate and adapt the 4BY1RPAQ and the 3DPAR questionnaires. Two pilot studies were conducted in order to: a) check the children's understanding of the questions and the material included in the translated versions of the two questionnaires, and b) determine the time required to read and complete them. The subjects in these pilot studies were Greek high school students, (n1 = 6 boys and 4 girls aged 13.57 + 0.70 years and n2 = 8 boys and 7 girls aged 13.64 + 0.70 years).

Where the subjects had difficulties in understanding the material given to them, additional information was included in the final versions of the questionnaires.

Study Design: All interviews were conducted in an environment familiar to the subject (school or home). Subjects were encouraged to maintain their daily physical activity schedule and in case of illness the study was discontinued. The MTI/CSA accelerometer was placed in a carrying pouch and participants were shown how to place the pouch on a belt at waist level on the right anterior axillary line. The investigator checked the functionality of the monitor every morning during the period of the study. Consistent and proper placement was emphasized, and subjects were told to wear the monitor at all times (day and night), even while sleeping, and to remove it only if the monitor would get completely wet, such as when showering or swimming. The investigators trained the subjects how to attach and detach the accelerometer. During both pilot studies, subjects would repeatedly forget to put on the MTI/CSA monitor as they were getting ready to go to school in the morning. This observation was the reason behind the decision to advise the children to continuously wear the MTI/CSA monitor. As a result, MTI/CSA data was collected for a period of 24 hours each day, which was also the case for the data from the questionnaires used in this study. Compliance was monitored by investigators every morning as the children arrived at school. The MTI/CSA was initialized according to the manufacturer's specifications. The epoch interval was set for one minute. At the end of the 7-day recording period the investigator used a reader interface unit to download the MTI/CSA data (counts) to a desktop computer. The data was then stored in an Excel file for further analysis.

Validation Procedure

The 3DPAR was completed by the children and returned to the investigator at the end of the third day. The 4-1DRPAQ was administered by the investigator for two weekdays and two weekend days and referred to the physical activity undertaken by the subject the previous day. The third questionnaire (PALQ) was completed just after the end of the seven-day period during which the subjects wore the CSA accelerometer. Data collection was completed within a period of one month since changes in weather conditions over long periods of time could affect the children habitual physical activity. The above procedure ensured that the questionnaires were recorded during identical periods of time, their guidelines were satisfied and activity recall from the completion of another questionnaire was minimized. Moreover, this design enabled the researchers to comparatively evaluate the data of all the measures of physical activity used in this study.

Reliability procedure

a) *Inter-observer reliability*: Subjects answered the PALQ according to the instructions from the researchers. Both researchers acting separately estimated the student's performance (in METs) by using the instructions of the evaluation protocol and assigned each person to one of the four activity categories. b) Reliability of repeated measurements: Repeated measurements were performed after one-week period in order to control for the test-retest reliability of the instruments. Reliability measurements lasted more than expected because in several cases the changeable weather conditions altered drastically the activity behavior of the participants. It is important to underline that the CSA reliability measurement was conducted during two non consecutive weeks due to very unstable weather conditions. In contrast, the reliability measurement of the three questionnaires was performed in two consecutive weeks. The same researcher estimated the activity scores of each participant in all questionnaires.

Statistical Analysis: The physical characteristics of the children were summarized using descriptive statistics. Intra class correlation coefficients were used for reliability control and Student's t-test was used for estimating differences in mean values for the repeated administrations of the CSA, the 3DPAR, the 4-1DRPAQ and the PALQ. Separate data transformations were performed and mean values and standard deviations have been calculated for all variables of each instrument separately. Spearman correlation coefficients between the CSA and the three questionnaires were used to assess their validity. The Spearman correlation coefficient was used since the correlation was based on the participant's ranking in each instrument according to the personal scores and not on the absolute values obtained. Significance for all parts of the analysis was determined at an alpha level of $p<0.05$.

RESULTS

Descriptive data

Table 1 includes descriptive data for the 40 participants of the study.

Table 1
Mean Value (M) and standard deviation (SD) for anthropometric data and age for the 40 participants of the study.

	Age (years)		Weight (kg)		Height (cm)		BMI *	
	MO	SD	MO	SD	MO	SD	MO	SD
Boys (N=23)	13.50	.9	58.74	12.2	165.7	11	21.3	3.53
Girls (N=17)	13.75	.9	53.41	10.86	160.2	6.3	20.3	3.3
Total (N=40)	13.65	.9	56.48	11.8	163.4	9.6	20.87	3.4

*BMI =Body mass index. Calculated with formula „Body weight (kg) /height2 (m)".

Table 2 presents mean values and standard deviations for all instruments for the first measurement. The PALQ slightly overestimating physical activity (M=37.13, SD=3.17) when compared with Cale's questionnaire (M=35.95, SD=3.33) for both genders. Independently of the instrument, boys are more active than girls.

Table 2.
Mean values (M) and standard deviations (SD) for the four instruments used.

	CSA (*Counts*)		3-DPAR (*kcal*)		4-1DRPAQ (*METs*)		PAL Q (*METs*)	
	M	SD	M	SD	M	SD	M	SD
Boys	674124.7 (N=18)	233428.5	2493.37 (N=23)	70385	37.48 (N=23)	3.61	38.26 (N=23)	3.7
Gilrs	478362.6 (N=15)	214606.3	2002.9 (N=16)	468.22	33.89 (N=17)	1.14	35.6 (N=17)	1.2
Total	585142 (N=33)	242683.1	2292.15 (N=39)	658.09	35.95 (N=40)	3.33	37.13 (N=40)	3.17

Reliability measures

Inter-observer reliability: Pearson r correlation coefficient for PALQ was 1.00 ($p<.001$) between the two researchers.

Test-retest reliability for all four instruments: Table 3 presents mean values (M) and standard deviations (SD) for all instruments for the first and second measurement and the correlation coefficients between the first and the second measurements as well as the Student's t-test values. The CSA accelerometer presented the lowest correlation between first and second measurement (r=.329), and the 3-DPAR presented the highest one (r=.861, p<.001). Statistically significant differences were found between the two measurements (p<.05), for the 3-DPAR and the PALQ. The results showed that all three instruments were sensitive enough to record changes in physical activity in the same direction.

Table 3.
Differences in mean values and intraclass correlation coefficients between the two measurements for the four instruments

	1st measurement		2nd measurement		t-test	r
	MO	SD	MO	SD	t	
CSA (Counts) (N=15)	669433	250893.47	677422.3	308469.3	t_{14}=-0.97*	.329
3-DPAR (kcal) (N=21)	2409.68	542.03	2284.58	503.06	t_{20}=3.174*	.861**
4-1DRPAQ (METs) (N=21)	36.52	3.25	35.43	2.57	t_{20}=1.783	.731**
PALQ (METs) (N=21)	38.52	3.69	36.17	1.96	t_{20}=2.597*	.772**

* = p<.05, ** = p<.001

Validity of the PALQ

Table 4 includes the correlation coefficient (Spearman r) for the four instruments assessing physical activity for all participants. The PALQ was medially correlated with CSA (r=.627, p<.001), with the 3-DPAR (r=.554, p<.001) and highly correlated with the 4-1DRPAQ (r=.791, p<.001). Similar correlation was found between all measures involved.

Table 4
Correlation matrix between the 4 instruments for all participants.

	CSA (Counts)	3-DPAR (kcal)	4-1DRPAQ (METs)	PALQ (METs)
CSA (N=33)	-			
3-DPAR (N=39)	.713**	-		
4-1 DRPAQ (Cale) (N=40)	.647**	.422**	-	
PAL Questionnaire (N=40)	.627**	.554**	.791**	-

Notes: a) *p<.05 και ** p<.001

b) Correlation matrix was based on pairwise comparisons.

Table 5 presents the correlation coefficients (Spearman r) for the 4 instruments recording physical activity by gender. According to these findings PALQ was not significantly correlated with CSA and the 3-DPAR for the girls' group. When data was plotted for boys the findings presented significant correlation for all four instruments.

Table 5
Correlations between instruments by gender.

	CSA (Counts)		3DPAR (kcal)		4-1DRPAQ (METs)		PALQ (METs)	
	B (N=18)	G (N=15)	B (N=23)	G (N=16)	B (N=23)	G (N=17)	B (N=23)	G (N=17)
CSA (N=33)	-	-						
3DPAR (N=39)	.550*	.390	-	-				
4-1DRPAQ (N=40)	.531*	.543*	.420*	.262	-	-		
PALQ (N=40)	.529*	.365	.582**	.412	.701**	758**	-	-

Notes: a) *p<.05 and ** p<.001.

b) Correlation matrix was based on pairwise comparisons.

The CSA and the3-DPAR provided a total score for each participant but they did not provide the possibility to the researcher to group the participants in different categories of physical activity. On the other hand the 4-1 DRPAQ and the PALQ use the same classification system and the same units of measurement. Table 6 presents differences in participants' classification according to their level of physical activity for these two instruments.

Table 6
Participants classification into activity levels for the 4-1DRPAQ and the PALQ.

	(1) Very inactive %		(2) Inactive %		(3) Moderately active %		(4 Active %	
	1η Measure ment	2η Measure-ment	1η Measure-ment	2η Measure-ment	1η Measure-ment	2η Measure-ment	1η Measure-ment	2η Measure-ment
4-1DRPAQ (N=40)	17,5% (N=7)	14.3%	55% (N=22)	57.2%	15% (N=6)	23.8%	12.5% (N=5)	4.8%
PALQ (N=40)	-	-	65% (N=26)	71.4%	22.5% (N=9)	19%	12.5% (N=5)	9.5%

According to the findings presented in Table 6, the PALQ overestimates physical activity in relation to the results provided by the 4-1DRPAQ. Following the results of the PALQ none of the participants was „very inactive" even though with the 4-1DRPAQ 17.5% and 14.3% of the subjects were characterized as „very inactive" for the first and the second measurement respectively. However, the participants characterized according to the 4-1DRPAQ as „very inactive" and as „inactive" stand for 65% of the total group for the first measurement and the 71.4% for the second measurement. The numbers produced from the PALQ for the same activity categories were 67.5% and 71.5% for the first and the second measurement respectively. There is therefore a high accordance between these instruments to identify the subjects who are target group for intervention efforts. The profile of physical activity formed by the PALQ for both boys and girls are presented in figures 1 and 2.

Figure 1. Allocation (%) of the weekly energy expenditure (METs) from participation in physical activities and sports for boys (PALQ).

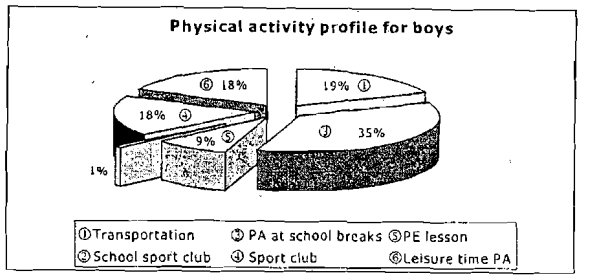
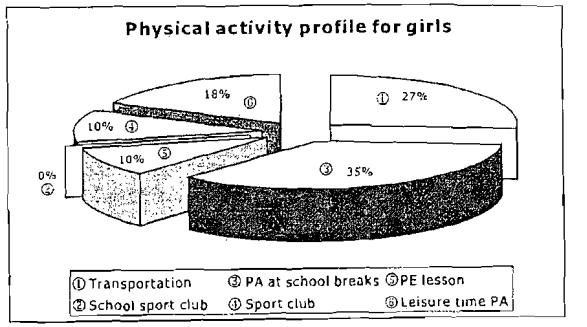


Figure 2. Allocation (%) of the weekly energy expenditure (METs) from participation in physical activities and sports for girls (PALQ).



Physical activities that took place at school account for the greatest part of weekly energy expenditure (45.4% girls and 44.7% boys) and in particular, during class breaks. However, is important to underline the very low rate of participation for both genders in organized sport activities at school or at sport clubs out of school environment (10.4% for the girls and 17.8% for the boys of their total energy expenditure in physical activities). Also, only the 17.5% of the total energy expenditure took place during free time for both genders. Statistically significant differences were found in physical activity scores between boys and girls for both measures ($t38=-2846$, $p<.05$).

DISCUSSION

The aim of this study was to assess the concurrent validity and reliability of the PALQ that was created in order to evaluate the physical activity patterns of young people in Greece. According to the findings the new questionnaires showed a satisfactory correlation with other physical activity measures and also show significant inter-observer reliability as well as reproducibility. Additionally, the PALQ was proven sensitive enough to record differences in physical activity between gender and repeated measurements.

The validity study revealed that the PALQ was satisfactorily correlated with the two other questionnaires assessing physical activity and the CSA device that were used as criterion standard. The correlations that were produced for the CSA accele-

rometer were higher when compared with the ones reported in other studies (Janz, 1994). However the validity findings in this study suggest the CSA is not highly correlated in general with questionnaires, a point of view also supported by other researchers (Kohl, Fulton & Caspersen, 2000). The results of this study may indicate that different instruments record different aspects of physical activity behavior, leading to the conclusion that high correlations are not easily attained. This is in accordance with the finding that the highest correlation was between the 4-1DRPAQ and the PALQ. These two instruments evaluate similar aspects of physical activity and use an identical protocol for estimating personal activity scores. On the other hand PALQ had the lowest correlation with the 3-DPAR. The reason for this may be that the 3-DPAR was constructed for clinical studies and its validity was indirectly estimated (Miller, Freedson & Kline, 1994). Several factors have contributed to deviations reported between the three questionnaires and the CSA device. These factors refer to:

a) The activities included in each questionnaire in order to produce a personal activity score and to the sensitivity of each questionnaire in recording physical activity. For example, the three questionnaires assign different energy values for similar physical activities. Additionally in the PALQ the participant is considered equally active during weekday and weekend days, a hypothesis that is not followed by the 4-1DRPAQ. On the other hand the CSA presents several manufacturer limitations since it cannot be used in activities as swimming and cycling. This may be possibly weakening the correlation with other instruments since several of the participants were regularly involved in the above activities. These limitations may lead to the conclusion that the CSA is not an appropriate objective criterion of reference.

b) The nature of units that each instrument uses. Even though the correlation between these instruments was based on scaling the participants' performance and not on the real values obtained, there were significant limitations in estimating personal scores with each instrument. More specifically, the energy cost of physical activities presented in the Compendium of Physical Activity (Ainsworth et al, 2000) refers to adults and not to children. Whereas, the 3-DPAR does not take into account the participants' different characteristics and at the same time it uses a gross intensity estimation of physical activity (Miller, Freedson & Kline, 1994).

c) The procedure that was followed in order to estimate the intensity and the time of participation in physical activity and sport. Since the assessment of physical activity involvement includes self-perceived estimation it seems that gathering information with questionnaires in young people may lead to an overestimation of physical activity ranging from 67% up to 112% (Sallis, Strikmiller, Harsha et al. 1996). This fact may be the reason for differences detected between the three questionnaires

since both the questions and scales that were used for estimating intensity and t involvement in physical activities were different for each instrument. In this stu female participants showed greater responsibility in completing the question and using the CSA device and this might be the reason for increased deviation lidity that was detected between the two genders. This finding needs further re since these differences have not been fully investigated (Kohl, Fulton & Casp 2000). Following the findings from PALQ and the other instruments, the male cipants were significantly more active than the female ones. The above findings accordance with the ones provided from other studies (Armstrong, 1998).

Even though the PALQ provided relatively constant data, the Student's performed showed significant differences between the two measurements for of the four instruments used in this study. These differences may be the re differences in weather conditions encountered during the two measurement significant environmental effect emphasizes the issue of accurately recording pl activity during different seasons of the year and the instability that the subjec havior may show regarding the engagement in physical activities and sport for periods of time (Sallis, Condon, Goggin, et al., 1993). This was clear from the ficant deviation observed on the data obtained from the CSA when used in two consecutive weeks and from the high reliability readings that the 3-DPAR sh when used four days apart. In the study of Janz (1994) referring to the reliab CSA in recording physical activity during three consecutive days, significant va was detected in day-to-day correlation.

Discouraging are the results that refer to all subjects according to whi majority of the participants have adopted a sedentary lifestyle. This percentag be even greater if one takes into account the fact that children tend to overes their physical activity level (Sallis et al, 1996). This finding may have very s ve implications since this behavior is very likely to continue into adulthood Dawson and Mohoney, 1999). Students' needs should be studied and underst larger groups and with the use of more accurate instruments in assessing ph activity. The study of the activity profile of the participants may lead to inte conclusions and areas of intervention. For example the energy expenditure fr gular participation in organized sport activities in and out the school enviro is negligible. In contrast with other studies (Miller, Freedson & Kline, 1994) st in this study were more active in school environment. It is noteworthy that ph activity was mainly recorded during the breaks between classes and partici in physical education classes and in school sport clubs had insignificant cont on to the total weekly percentage. Improving school sport infrastructure, incr

physical education time and creating the preconditions for participating in organized sport activities may be feasible actions to confront the problem of inactivity. The small percentage of physical activity recorded during free time is possibly related to lack of leisure time due to a heavy schedule at school (Arabatzoglou & Antoniou, 1994) and to the difficulty in securely accessing recreation facilities (Sallis, 1993). The distinctive feature of PALQ classifying individuals in activity levels and at the same time creating a physical activity profile seems to be useful in setting priorities when designing physical activity intervention programs.

Several unpredicted problems occurred during this study. The validation procedure was proven very demanding for the participants. Some subjects had difficulties in grouping the activities when filling out the 3-DPAR. The use of CSA in this study revealed the difficulty of using an objective method to record physical activity in field studies (Montoye, Kemper, Saris & Washburn, 1996). While completing the PALQ subjects had trouble recalling events and significant activities that had already been recorded in the other instruments with shorter recall periods. However for reliably evaluating physical activity with an objective instrument requires continuous recording of at least 4 to7 days (Trost, Pate, Freedson, Sallis & Taylor, 1999). For increased validity and reliability readings for the PALQ additional studies should be conducted during different seasons of the year (Pratt, Macera, & Blanton, 1999). Additionally, reliability and validity evidence should be provided for the separate parts of PALQ in representative samples of different age groups and urban and rural areas of the country. Further studies should also investigate the convergent validity PALQ with other more advanced procedures in assessing physical activity.

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