Reproducibility and validity of the International Physical Activity Questionnaire (IPAQ) in elderly men

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ABSTRACT

It is necessary to efficiently and economically find means to quantify the level of physical activity of the population. Questionnaires are viable and economical; however, their trustworthiness is questionable. This study aimed to determine the reproducibility and validity of the International Physical Activity Questionnaire (IPAQ) in elderly men. The sampling was composed of 29 elderly men over the age of 60, average age of 66.6 years (SD = 4.3), who were members of the extension program at the Federal University of Santa Catarina. The instruments used were: a) IPAQ extended version; b) pedometer and c) Bouchard's Physical Activity Diary (PAD). For reproducibility, the IPAQ was applied twice with a 21 day interval (r_s = 0.95). The statistical analysis used was Spearman Correlation (r_s); Concordance Percentile (%C); Kappa Index (k); and Bland and Altman plot. The sample was divided using the median as criterion. The reproducibility showed a correlation of r_s 0.95. The combination between IPAQ and PAD was: r_s = 0.38; %C = 69 and k = 0.04. The combination between IPAQ and the Pedometer was: r_s = 0.24; %C = 62 and k = 0.19. It was concluded that the validity varied from moderate to low while the reproducibility was adequate.

Keywords: Measurement. General practice. Surveillance. IPAQ.

INTRODUCTION

Regular physical activity reduces the risk of mortality and morbidity**,** regardless of other alterations in lifestyle[1-4].

According to the Ministry of Health, in Brazil circulatory diseases are the main causes of death (32%)[5]. Physical inactivity is one of the important risk factors that lead to chronic-degenerative diseases. 83% of the Brazilian population does not practice any kind of physical activity. Besides that, above 54 years of age, 38,7% of women have circumference above 88 cm and 15,6% of men, above 102 cm, means which are considered risk factors for the development of cardiovascular diseases[6]. The *disuse syndrome* (physical inactivity) caused by the lack of movement and body exercises tremendously increases the search for medical assistance. Moreover, a dependence on other people relationship seems to be early developing in the elderly[7].

A growing need of strategies and actions in order to promote collective health which includes physical activity and means to quantify it has been observed. Physical activity is an important component of a healthy lifestyle, especially by the evidence of its several benefits. The practice of physical activities is associated with the decrease of cardiovascular diseases and diabetes, among others[3]. Paffenbarger *et al.*[3] observed a dose/response relationship in which the risk for these diseases progressively decreased when the total energetic cost in weekly physical activity increased; being considered optimum between 1500 and 3500 Kcal; although its benefits may be observed from 500 Kcal/week. Nonetheless, it is challenging to measure the total energetic cost of physical activities, which makes the implementation of suitable programs difficult.

Therefore, the World Health Organization (WHO); the American Center for Disease Control and Prevention (CDC) and the Karolinska Institute in Sweden, joined researchers with the purpose to develop and test an instrument which would obtain measurements of physical activities internationally comparable. It was proposed with this aim the *International Physical Activity Questionnaire – IPAQ*, validated in 12 countries and 14 research centers. The IPAQ is a questionnaire which allows the estimation of weekly time spent on physical activities of moderate and strong intensity, in different contexts of the daily life, such as: work; transportation; housework and leisure besides the time spent in passive activities performed on the seating position. The questionnaire was published in its short and long versions The IPAQ short version consists of seven open questions and its information allow to estimate the time spent per week in different dimensions of physical activity (walks and physical exertions of moderate and vigorous intensities) and of physical inactivity (seating position). The IPAQ long version presents 27 questions related with physical activities, performed in an ordinary week, with vigorous, moderate and mild intensities, with minimum duration of 10 continuous minutes, distributed in four dimensions of physical activity (work; transportation; housework and leisure) and of the time spent per week in the seating position. When the IPAQ short and long versions were compared, the results are different[8]. In the short version, the weekly time spent in moderate and vigorous physical activities has been shorter than in the long version. Such fact may be explained by the difference in the number of domains in each version and the number of questions, since in the long version each domain is more explored.

In Brazil, the IPAQ has been tested by several researchers[9-13] concerning reproducibility (test/retest) as well as concomitant validity. Generally, the results derived from these studies show that the IPAQ (usual week, self-administered through individual interview) is an instrument with good stability of measurements and acceptable accuracy for use in epidemiological studies with young adults, middle aged- adults and older women.

However, little is known about the validity of utilization of this instrument with children and older men. Mazo *et al.*[14] highlight the difficulty in obtaining measurements of the physical activity in older individuals, especially in studies which involve large number of subjects. In this situation the questionnaires seem to be the option with greatest viability. One of the instruments tested by the authors was the Questionnaire by Baecke, modified for older sub-

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jects, which presented good stability among measurements of reproducibility. However, the concomitant validity level was only modest (when correlated with the physical activities file (DAF) and the pedometer). Similar data were found in the application of the IPAQ Questionnaire applied for older women[12].

The literature presents a gap concerning valid instruments for the measurement of physical activity in older men. Therefore, the present study had as aim to verify the reproducibility (test/retest) as well as the concomitant validity of the Physical Activity Questionnaire (IPAQ version 8, long version for usual/ordinary week) in the evaluation of the physical activities level of older men.

METHODS

This study is part of the project "The Elderly Profile of Florianópolis County" and was approved by the Human Ethics Committee of UFSC, in 30/07/2001 (project 051/2001). All volunteers signed a free and clarified consent form.

The sample consisted of 29 older men, members of the extension project "Physical Activities for the Third Age" from the Federal University of Santa Catarina (UFSC).

For this study, a long version, ordinary/usual week IPAQ questionnaire adapted by Benedetti *et al.* was designed[12] in order to facilitate the understanding on older population as well as the register of the calculation of the number of hours, according to appendix 1. Thus, examples of activities that are common to Brazilian older subjects, specifically in Florianópolis county were included in the IPAQ questions in the answers field, instead of simply indicating the weekly frequency and the time of performance of the respective physical activities. A table in which the interviewer should register the time concerning each day of the week as well as in its different shifts (morning, afternoon and night) in each question was also included. The times were added in order to obtain the total weekly cost prior to the interview.

In order to test the IPAQ validity, its result was compared with the ones obtained through the physical activities file (DAF)[15] and the pedometer.

The DAF allows the estimation of the physical activity level as well as the energetic cost concerning a given period of observation, based on detailed description and performed by the subjects throughout the day. Moreover, the day is divided in 96 periods of 15 minutes, categorized in 9 levels of intensity[15].

The pedometer is a mechanical counter which registers movements performed in response to the body's vertical acceleration. It is attached to the waist, close to the navel, on one's belt or clothes and counts the steps as well as calculates the caloric cost according to the individual's body weight, storing the data to be noted by the subjects. In this study, the CITIZEN pedometer, model TW-30 was used.

The IPAQ was twice applied (test and retest), with interval of 21 days, in individual interviews in order to obtain information concerning stability of their measurements. The DAF and the pedometer were simultaneously applied during three days: two during the week and one on Sunday.

For the estimation of the energetic cost in physical activities, with the data collected through the IPAQ, the procedures described by Craig *et al.* were adopted[13]. For the DAF, the mean energetic demand of the three days of register was used; for the pedometer, the caloric cost according to the body weight registered in the equipment in the three days of research was verified. The comparison of the data obtained through the IPAQ (kcal/day), with the data derived from the DAF (kcal/day) and the pedometer (kcal/day) was determined by indicators of concomitant validity.

For the analysis of the test/retest reproducibility of the IPAQ, the Spearman Correlation (r_s) was performed, considering the final scores of the applications of the IPAQ obtained from the sum of each of the specific dimensions which constitutes the instrument (work, transportation, housework tasks and leisure).

For the analysis of the concomitant validity, the Concordance Percentile (%C); the Kappa index (k); the Spearman Correlation (r_s) between the estimates of energetic cost obtained by the application of the IPAQ and the measurements of the physical activities derived from the pedometer's data as well as the DAF were used.

Both for the analysis of the reproducibility and the concomitant validity the Bland and Altman plot in dispersion diagram was used[20]. Such procedure allows the visualization of the different means and the extreme limits of concordance, in the case of two standard deviations of difference.

The data analysis was performed through the statistical package SPSS, version 10.0 for Windows, being considered the significance level of $p < 0,05$.

RESULTS

Twenty-nine retired men, aged at least 60 years, majority mean age of 66,6 (± 4,3) years, mean body weight of 73,3 (± 10,48) kg participated in the study.

Reproducibility

The value obtained in the Spearman Correlation was $r_s = 0,95$, which indicates good stability between measurements (test/retest), with statistically significant result ($p < 0,01$).

Concordance of the measurements of physical activities between IPAQ test and retest according to Bland-Altman procedure [20] in elderly men may be observed in figure 1.

The mean values between variables are reported in the abscises, and in the ordinates, the individual differences between the results of the instrument are reported. Such analysis procedure was proposed by Bland and Altman[20] and enables the visualization of the differences between the means and the extreme limits of concordance (± 2 SD of the difference), presented by the different instruments applied and analyzed. The graphic sorting presents medium variation between the standard deviations. The differences between the means of the test and retest application are close to the means between the questionnaire application. However, a

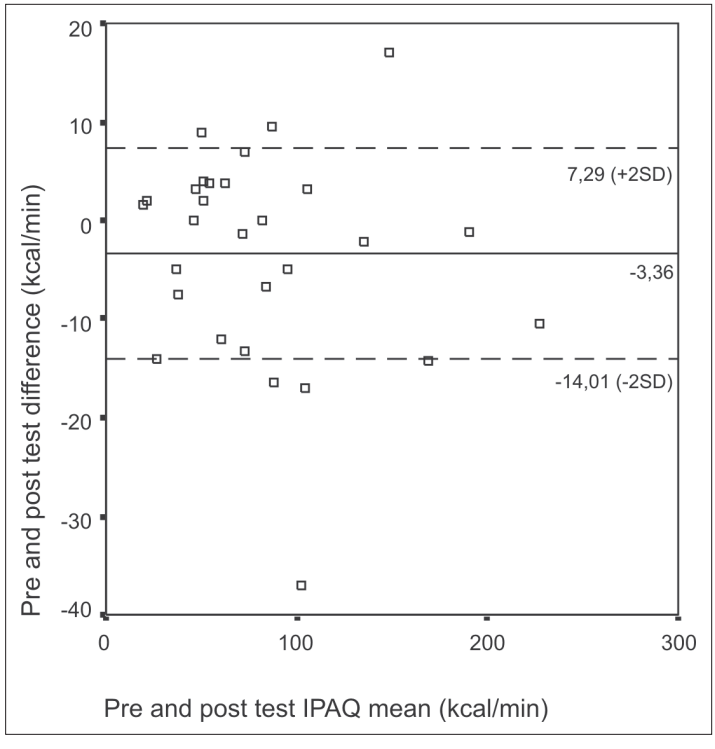

Figure 1 *– Concordance of measurements of physical activities between IPAQ test and retest according to Bland-Altman procedure in older men*

APPENDIX 1
International Physical Activity Questionnaire – IPAQ
Long, usual/ordinary week, adapted by Benedetti *et al.*[12]

The questions are related to the time you spend doing physical activity in an **ordinary/usual** week

In order to answer the questions remember that:

- **Vigorous** physical activities are those that need great physical exertion and that make you breathe **much** deeper than usually.
- **Moderate** physical activities are those that need some physical exertion and make you breathe **a little** deeper than usually.
- **Mild** physical activities are those in which physical exertion is normal and make you breathe **normally**.

FROM QUESTIONS 1B TO 4C THE TABLE BELOW SHOULD BE AVAILABLE TO BE FILLED OUT.

Week Day	Time hours/Min. morning	afternoon	evening	Week Day	Time hours/Min. morning	afternoon	evening
Monday				Friday			
Tuesday				Saturday			
Wednesday				Sunday			
Thursday				XXXXXX			

DOMAIN 1- PHYSICAL ACTIVITY AT WORK: This domain includes the activities that you do at your paid or volunteer work as well as school or college activities (intellectual work). Do not include housework tasks such as taking care of the garden, house, or looking after your family. These will be included in Domain 3.

1a. Do you currently have a paid occupation or do volunteer work outside your household?

( ) Yes ( ) No – **In case you answer no go to Domain 2**: **Transportation**

The next questions are related with all physical activity you do in an **ordinary/usual** week as part of your paid or volunteer work. **Do not include** transportation to work. Think only of those activities which last **at least 10 continuous minutes** at work:

1b. How many days and how long (hours and minutes) during an ordinary week you perform VIGOROUS activities such as: heavy construction work; lifting and moving heavy objects; cutting log; sawing wood; mowing the lawn; painting the house; digging; climbing ladders **as part of your paid or volunteer work for at least 10 CONTINUOUS MINUTES**?

_____ hours _____min. _____days per **week** ( ) None. **Go to question 1c.**

1c. How many days and how long (hours and minutes) during an ordinary week you perform **MODERATE** activities such as: lifting and moving small objects; doing the laundry by hand; washing windows; sweeping or mopping the floor; carrying children, **as part of your paid or volunteer work, for at least 10 CONSECUTIVE MINUTES?**

_____ hours _____min. _____days per **week** ( ) None. **Go to question 1d.**

1d. How many days and how long (hours and minutes) during an ordinary week you **WALK AT** your paid or volunteer **WORK for at least 10 CONTINUOUS MINUTES**? Please, **do not include** walking as means of transportation from or to paid or volunteer work.

_____ hours _____min. _____days per **week** ( ) None. **Go to Domain 2 – Transportation**.

DOMAIN 2 – PHYSICAL ACTIVITY AS MEANS OF TRANSPORTATION

These questions refer to the usual way you go from you place to another, including your social group for the elderly; church; supermarket; work; cinema; stores an others.

2a. How many days and how long (hours and minutes) during **an ordinary week** you **RIDE THE BUS AND CAR/MOTORCYCLE?**

_____ hours _____min. _____days per **week** ( ) None. **Go to question 2b.**

Now, think only of walking or cycling to go from one place to another in an ordinary week.

2b. How many days and how long (hours and minutes) during an ordinary week you **RIDE A BICYCLE** to go from one place to another for **at least 10 continuous minutes**? (**Do not include cycling for fun or exercising**)

_____ hours _____min. _____days per **week** ( ) None. **Go to question 2d.**

2c. How many days and how long (hours and minutes) during an **ordinary** week you **WALK** to go from one place to another such as: to go to the social group for the elderly; church; supermarket; doctor's; bank; visit a friend; neighbor and family members **for at least 10 continuous minutes?**

(DO NOT INCLUDE Walks for Fun or Physical Exercise)

_____ hours _____min. _____days per **week** ( ) None. **Go to Domain 3**.

DOMAIN 3 – PHYSICAL ACTIVITY AT HOME: WORK, HOUSEWORK AND TAKING CARE OF FAMILY

This part includes physical activities you do in an **ordinary/usual** week in and around your house or apartment. For instance: housework; taking care of the garden; taking care of the yard; house maintenance and taking care of the family. Again, think only of those activities with duration of **at least 10 continuous minutes.**

3a. How many days and how long (hours and minutes) during an ordinary week you do **VIGOROUS** physical activities **AROUND YOUR HOUSE OR APARTMENT (YARD OR GARDEN)** as: weeding; cutting log; sawing wood; painting the house; lifting and carrying heavy objects; mowing the lawn; for at least **10 CONTINUOUS MINUTES**?

_____ hours _____min. _____days per **week** ( ) None. **Go to question 3b.**

3b. How many days and how long (hours and minutes) during an ordinary week you do **MODERATE** activities **AROUND your house or apartment** (garden or yard) such as: lifting and carrying small objects; cleaning the garage; gardening in general; for **at least 10 continuous minutes**?

_____ hours _____min. _____days per **week** ( ) None. **Go to question 3c.**

3c. How many days and how long (hours and minutes) during an ordinary week you do **MODERATE** activities **INSIDE your house or apartment** such as: carrying light loads; washing the windows; doing the dishes; cleaning the bathroom and the floor; for **at least 10 continuous minutes**?

_____ hours _____min. _____days per **week** ( ) None. **Go to Domain 4.**

DOMAIN 4 – RECREATIONAL, SPORTS, EXERCISE AND LEISURE PHYSICAL ACTIVITIES

This domain refers to physical activities you do in an **ordinary/usual** week only for recreation, sports, exercise or leisure. Again, think only of the physical activities you do for **at least 10 continuous minutes**. Please, **do not include activities you have already mentioned**.

4a. Not considering any walk you have previously mentioned, how many days and how long (hours and minutes) during an ordinary week, you **WALK (physical exercise)** in your free time for **at least 10 CONTINUOUS MINUTES**?

_____ hours _____min. _____days per **week** ( ) None. **Go to question 4c.**

4b. How many days and how long (hours and minutes) during an ordinary week, you do **VIGOROUS** activities **in your free time** such as: running; fast swimming; body shaping; canoeing; rowing; sports in general; for **at least 10 continuous minutes**?

_____ hours _____min. _____days per **week** ( ) None. **Go to question 4d.**

4c. How many days and how long (hours and minutes) during an ordinary week, you do **MODERATE** activities **in your free time** such as: cycling at a moderate pace; playing recreational volleyball; doing water gymnastics; doing gymnastics for the third age; dancing, for **at least 10 continuous minutes**?

_____ hours _____min. _____days per **week** ( ) None. **Go to Domain 5.**

DOMAIN 5 – TIME SPENT SITTING

These last questions are about the time you remain sitting in different places such as: at home; in the social group for the elderly; in the doctor's office and others. It also includes the sitting time while resting; watching television; doing handcrafts; visiting friends and family members; reading; talking on the telephone; and having meals. **Do not include the sitting time spent while riding the bus, car, train and subway**.

5a. How much time do you spend altogether sitting during **ONE** ordinary week DAY?

ONE DAY _____hours ____minutes

Weekday One day	Time hours/Min. morning	afternoon	evening

5b. How much time do you spend altogether sitting during **ONE DAY** of an ordinary weekend?

ONE DAY _____hours ____minutes

Weekday One day	Time hours/Min. morning	afternoon	evening

moderate variation in the caloric cost between applications is observed.

The reliability interval (± 2SD) between the test and retest IPAQ application was 7,29 to –14,0 (kcal/min); these results show an individual variability concerning the questionnaire application concordances.

Validity

Table 1 shows the concordance percentile; the Kappa index and the Spearman Correlation in the IPAQ concomitant validity evaluation and the measurements of physical activities obtained with the pedometer and DAF data.

TABLE 1
Concordance coefficient (%C), Kappa Index (k) and Spearman Correlation (r_s), in the evaluation of IPAQ concomitant validity against measurements of physical activities obtained with the pedometer and DAF data

Variable	Classification of the physical activities measurements	
	IPAQ x Pedometer	IPAQ x DAF
Concordance coefficient (%)	62	69
Kappa Index (k)	0,03	0,35*
Spearman Correlation (r_s)	0,24	0,38*

* Statistically significant (p < 0,05).

The concordance percentile between IPAQ x pedometer (62%) and IPAQ x DAF (69%) was good.

The Spearman Correlation and the Kappa Index between IPAQ x pedometer, (r_s = 0,24; K = 0,03) and IPAQ X DAF (r_s = 0,38; K = 0,35) were low. Nevertheless, between IPAQ X DAF there was statistically significant difference (p < 0,05).

The sorting diagrams with the plot of mean values of the caloric cost of the pedometer and IPAQ and the DAF and IPAQ may be observed in figures 2 and 3.

The graphic sorting in figures 2 and 3 presents great variation between Standard deviations, being observed a great variation in the caloric cost, using one or the other instrument. The mean differences between the instruments should be the closest as possible to the means between the instruments. Although it has happened, the majority of the older individuals were within the two standard deviations set.

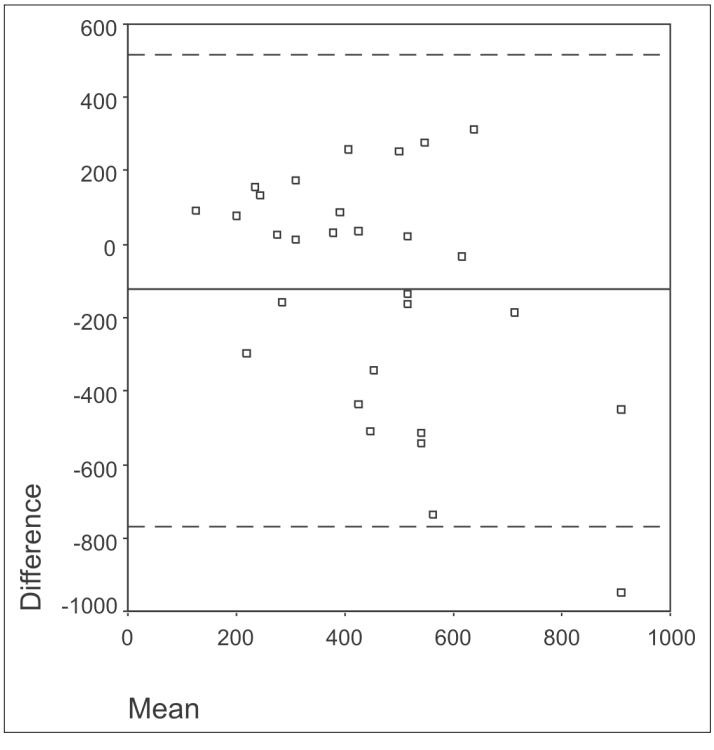

Figure 2 *– Concordance of physical activities measurements between IPAQ and pedometer, according to the Bland-Altman procedure, in older men*

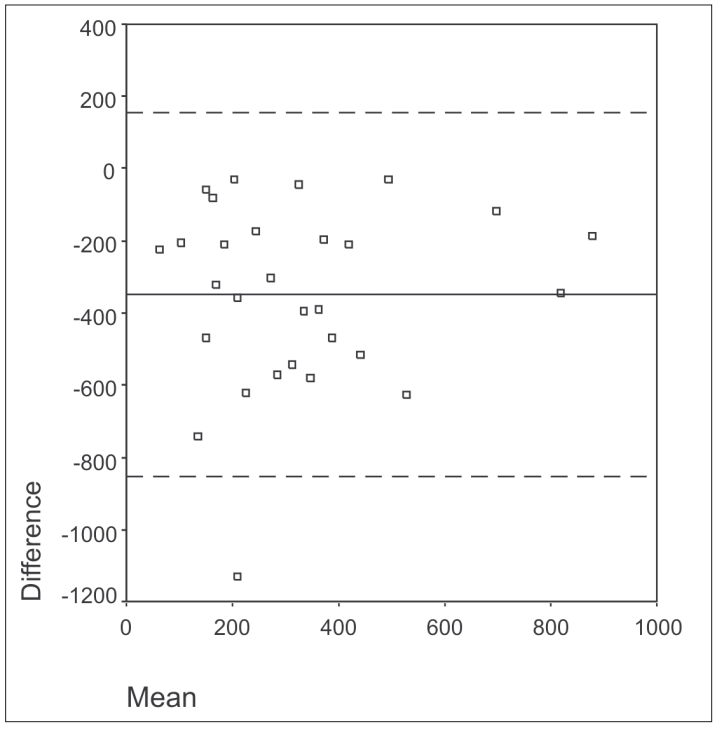

Figure 3 *– Concordance of measurements of physical activities between* IPAQ *and daily, according to the Bland-Altman procedure, in older men*

DISCUSSION

Reproducibility – According to the data presented in the partial report of the Executive Committee for the IPAQ evaluation[13], several studies performed with samples derived from 12 countries presented results lower than the ones found in this study, which Spearman correlation was of r_s = 0,95, which shows good stability between the test and retest measurements. Concerning the estimate of the total physical activity level, Craig *et al.*[13] verified that the Spearman correlation indices varied r_s = 0,46 in South Africa and r_s = 0,92 in Italy, while in Brazil such index reached r_s = 0,69[13]. The reproducibility through the Spearman correlation as well as the self-administered short version IPAQ questionnaire applied in adolescents of both sexes, varied between 0,49 and 0,83[21].

In the present study, the reliability interval (± 2dp) between the IPAQ test and retest varied between 7,29 and –14,0 (kcal/min). These results demonstrate the moderate individual variability. The higher the breadth observed between the reliability intervals limits, the lower the reliability of the instrument.

Validity – the data found in table 1 show that the concordance coefficient (%) between the IPAQ results with the ones from the Pedometer and DAF are good.

The Kappa index (k) and Spearman correlation results are low both for IPAQ x Pedometer measurements and IPAQ x DAF. Therefore, one may observe that such results corroborate the evidence already presented in other studies[8-10,21]. They also agree with the indicators presented in the partial report of the Executive Committee of the IPAQ evaluation[13].

When the IPAQ results applied in older men were compared with the ones in older women, the concordance coefficient with the pedometer and DAF were of the same magnitude (IC = 63%-68% respectively). The Kappa index (k) was also similar in women with the pedometer (k = 0,27) and with the DAF (women k = 0,37), not varying much in the data[12].

It is relevant to mention that the physical activity level evaluation obtained with the utilization of the IPAQ considers the usual activities of the elderly, while the information obtained through the pedometer present limitation in its use, once it simply registers certain types of activities, which could not reflect the usual behavior of the elderly. The same limitation can be also found when comparing the IPAQ and the DAF data, since the data collection of the latter depends on the behavior register in a given observation period, which could mask the typical behavior as well. Despite that, due to the existence of alternatives accessible to these procedures, these instruments have been widely applied[16-19].

The Spearman correlation of the indicators of concomitant validity between the measurements obtained through the IPAQ and the pedometer was of r_s = 0,24 (p = 0,20). Contrasting the IPAQ measurements with the measurements obtained through the DAF, the index was higher: r_s = 0,38 (p = 0,04). Despite being low, the index was statistically significant. Although the value was not the expected one, these results agree with the ones reported by the Executive Committee for IPAQ evaluation[13] as well as the ones found in older women[12]. Other studies that used more accurate movement sensors (Computer Science & Applications – CSA) in order to obtain reference measurements for evaluation of the concomitant validity presented also fairly modest validity indicators[14]. It was also verified low correlation between the IPAQ (self-administered short) and the DAF in adolescents, being the correlation r_s = 0,39 and the Kappa coefficient presenting analogue results[21].

Low correlation between the IPAQ and the pedometer was observed. The concordance percentile was of 62%; however, the Kappa index was low and not significant.

The mean differences between the instruments should be the closest as possible. However, a great variation in the estimate of the caloric cost is observed when using one or the other instrument.

A grouping in the points is observed in figures 2 and 3. In both figures the reliability intervals (± 2SD) between the IPAQ and the pedometer (514 to –767,1) and between the IPAQ and the DAF (154 to –854), demonstrate a high individual variability concerning the concordances of the questionnaire application and the standard instruments utilized. The higher the breadth observed between the reliability intervals limits, the lower the validity of the instrument evaluated. Thus, the results of the present study suggest that the IPAQ may be a reliable instrument, especially to discriminate two groups of activities (mean: more and less active).

Therefore, the IPAQ is an acceptable measurement instrument to measure the physical activity level in different places and languages; it is of easy application and low cost for large populations. Moreover, it has been tested in twelve different countries and can be used in order to measure the physical activity level in Brazilian older individuals.

CONCLUSION

The results obtained in this study show that the International Physical Activity Questionnaire (IPAQ); long version; usual/ordinary week; presents excellent test/retest reproducibility level when evaluated through the Spearman correlation and good reproducibility when evaluated through the Bland and Altman technique. The reliability was higher than the one found in validity and reproducibility studies conducted in Brazil with young adults, adolescents, middle-aged individuals and older women.

Concerning the concomitant validity, one may infer that the concordances between the IPAQ and the pedometer as well as the IPAQ and the DAF instruments are moderate. Satisfactory discrimination capacity in two groups (more active and less active) may be suggested.

All the authors declared there is not any potential conflict of interests regarding this article.

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