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CRITERION, CONSTRUCT AND FACTORIAL VALIDITY OF THE GREEK VERSION OF THE INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE-SHORT FORM (IPAQ-SF)

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Abstract:
The current study investigated the validity of the Greek version of the International Physical Activity Questionnaire-short form (IPAQ-SF, seven days recall period, Craig et al., 2003). Specifically, criterion and construct validity were examined in a sample of 120 adults ($M \pm SD$ = 30.52 ± 14.87 years). In addition, factorial validity and internal consistency were examined in a second sample of 726 physically active adults ($M \pm SD$ = 38.80 ± 13.64 years). Further, associations were examined among the IPAQ-SF, exercise self-efficacy, body mass index and various socio-demographic variables. The statistical analyses indicated: (a) acceptable validity coefficients and factorial validity of the IPAQ, (b) acceptable internal consistency, (c) higher physical activity values in men compared to women and in athletes compared to non-athletes, (d) positive correlations between physical activity levels, exercise self-efficacy and past physical activity and (e) negative correlations among physical activity, age, number of children and body mass index. The Greek version of the IPAQ-SF was valid and therefore, could be useful for assessing physical activity.

Keywords: validation; factor structure; internal consistency; exercise

1. Introduction

Regular physical activity (PA) has been proven to be an effective strategy for the prevention and treatment of obesity, metabolic syndrome, cardiovascular diseases, as well as, for the reduction of mortality rates (Warburton & Bredin, 2016; WHO, 2018). Despite the apparent benefits of PA, the Eurobarometer survey in European Union

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countries has indicated an increase from 42% to 46% of adults that never engage in exercise, sports or PA since the previous survey in 2014 (European Commission, 2019). PA has been defined as "*any bodily movement produced by skeletal muscles and results in energy expenditure*" and is a complex behaviour to measure (Skender et al., 2016; Warren et al., 2010). Due to its complexity and multidimensionality, various methods to assess PA have been developed including objective measures, such as pedometers, accelerometers, heart rate monitors, calorimetry, doubly labeled water, as well as, self-report measures, such as questionnaires and diaries (Skender et al., 2016; Warren et al., 2010).

Although objective measures of PA are more accurate methods, self-reports measures are cheaper, noninvasive, easy to administer and appropriate for large-scale epidemiological studies (Skender et al., 2016; Warren et al., 2010). Among self-reports measures, the International Physical Activity Questionnaire (IPAQ) is the most frequently used questionnaire in order to assess adults' PA (Craig et al., 2003; Lee, Macfarlane, Lam, & Stewart 2011; Warren et al., 2010). Eight different forms of the IPAQ have been developed and their psychometric properties have been examined in 12 countries. The last 7-day, short form (SF) of the IPAQ has been proposed to be used for national and regional prevalence studies (Craig et al., 2003; Lee et al., 2011). The IPAQ-SF consists of six items assessing four PA indexes such as walking, moderate, vigorous and total PA. The validity and reliability of the IPAQ-SF have been examined in various countries (Acs et al., 2021; Craig et al., 2003; Ekelund et al., 2006; Tran, Lee, Au, Nguyen, & Hoang, 2013). In addition, the Greek version of the IPAQ-SF has been examined in students indicating medium positive associations among the vigorous and total PA indexes with aerobic capacity, as well as, acceptable test-retest reliability (Papathanasiou, et al., 2009; Papathanasiou, et al., 2010).

However, future studies should be carried out to further examine the criterion validity and other validity types of the IPAQ-SF Greek version in adults 18-65 years old. Therefore, the purpose of the current study was to examine the criterion, construct and factorial validity and internal consistency of the Greek version of the IPAQ-SF.

2. Material and Methods

2.1 Participants

a. Criteria of Sample Selection

The participants' selection criteria were the following: (a) 18-65 years old and (b) no missing values. Two independent not randomly selected samples were used.

b. First Sample

The first sample consisted of 120 participants, 51 either sedentary or physically active adults and 69 University students (Figure 1). Specifically, the participants were 67 men (55.83%) and 53 women (44.17%) ranging in age from 18 to 66 years old ($M \pm SD = 30.52 \pm 14.87$ years).

c. Second Sample

As Figure 1 presents, the second sample consisted of 752 participants (n_{men} = 212 and n_{women} = 540), ranging in age from 18 to 65 years old, agreed to fill in the questionnaires and participated in various physical activities and exercise programs. However, 26 of the participants were excluded from the analyses due to incomplete information (missing values etc.). The remaining 726 participants consisting of 209 men (28.79%) and 517 women (71.21%) with a mean age of 38.80 years old (*SD* = 13.64 years) were used for the analyses.

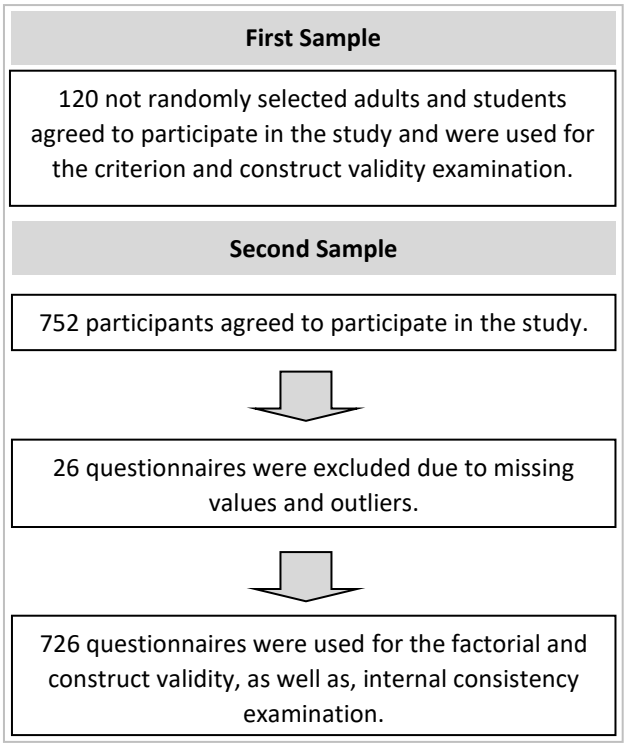

Figure 1: Sampling Diagram

2.2 Measures

a. International Physical Activity Questionnaire – Short Form (IPAQ-SF)

The IPAQ-SF evaluates PA for a seven days recall period and consists of six items measuring exercise frequency and duration and one item about sedentary life (Craig et al., 2003). The six items assess four PA indexes such as walking PA, moderate PA, vigorous PA and total PA. The total PA index is calculated by adding the walking, moderate and vigorous PA indexes. The PA indexes are expressed in MET - minutes per week and are calculated as follows: duration X frequency per week X MET intensity. The sedentary life's item measures the sedentary time in a usual day of the past seven days in hours per day. Acceptable validity and reliability properties of the IPAQ-SF have been provided (Acs et al., 2021; Craig et al., 2003; Ekelund et al., 2006; Tran et al., 2013).

b. Godin Leisure-time Exercise Questionnaire

The Godin Leisure-time Exercise Questionnaire was used to estimate the criterion validity of the IPAQ-SF (Godin & Shephard, 1985). It's a valid and reliable questionnaire

that measures the frequency of exercise activity for a period longer than 15 minutes per session during leisure-time of a typical seven-day period. Specifically, participants are requested to fill in "how many times per week they participate in mild, moderate and strenuous exercise and activities" (Godin & Shephard, 1985; Kriska & Caspersen, 1997). The items assess a weekly PA index that is expressed in MET - minutes per week and is calculated based on the frequency per week X MET intensity (3 METs for mild, 5 METs for moderate and 9 METs for strenuous activities). Acceptable validity and reliability of the Greek version of the Godin Leisure-time Exercise Questionnaire have been found (Moustaka, Vlachopoulos, Kabitsis, & Theodorakis, 2012).

c. Social Desirability Scale

The Social Desirability Scale is a widely used questionnaire that assesses whether or not respondents are concerned with social approval (Crowne & Marlowe, 1960). Several versions of the Marlowe-Crowne scale have been proposed and adopted by researchers (Loo & Thorpe, 2000). In this study, the 13 items Greek version of the Social Desirability Scale was used, which was proved to be valid and reliable (Lavidas & Gialamas, 2019).

d. Exercise Self-Efficacy Scale

The five-item Exercise Self-Efficacy Scale (Marcus et al., 1992) is a widely used instrument for assessing exercise self-efficacy. This scale was designed to evaluate one's confidence in his/her ability to persist in exercising under the following adverse situations: tired, bad mood, not having time, on vacation and raining or snowing. The validity, internal consistency (α = 0.72–0.78) and test-retest reliability (r = 0.90) of the scale are well established (Marcus, Selby, Niaura, & Rossi, 1992), which was confirmed for its Greek version (Theodoropoulou, Stavrou, & Karteroliotis, 2021).

e. Body Mass Index (BMI)

Height and weight were recorded. BMI was calculated as weight (kg) divided by height (m) squared.

f. Socio-demographic Variables

Age, gender, educational level, marital status, number of children, type of job, income, years of past PA, years of previous participation in sports and years of present participation in sports were recorded.

2.3 Study Design and Procedure

All participants were informed about the procedures of this cross-sectional study and signed a written consent form. Institutional ethical approval was obtained through the University. As Figure 1 presents, the first sample filled in the questionnaires for the criterion and construct validity examination. Then, to test the factorial and construct validity and internal consistency of the IPAQ-SF in a second independent sample, 752 participants filled in the questionnaires.

2.4 Data Analyses

Phase 1: Criterion and Construct Validity Testing

At first, 120 participants were used in order to examine the criterion and construct validity of the IPAQ-SF. Specifically, to both assess the criterion validity and control socially desirable answering, the participants on the one hand completed both the IPAQ-SF and the Godin Leisure-time Exercise Questionnaire and on the other hand filled in the Social Desirability Scale. Low and insignificant associations between the IPAQ-SF and the Social Desirability Scale would be proof of not socially desirable answers. Bivariate correlation coefficients among the questionnaires were applied.

To investigate the construct validity, the differences in IPAQ-SF were examined between: (a) men and women and (b) athletes and non-athletes students. *T*-tests for independent samples were applied. The hypotheses were that men compared to women and athletes compared to non-athletes students would have higher vigorous and total PA values. In addition, the correlations were examined among the four PA indexes of the IPAQ-SF and: (a) BMI, (b) socio-demographic variables, (c) past PA, (d) past participation in sports and (e) present participation in sports. Bivariate correlation coefficients were applied. The hypotheses were that negative associations would be indicated among the PA indexes of the IPAQ-SF and age and BMI, whereas positive associations would be found among the PA indexes and past PA and sports participation and present participation in sports. To examine the distributions of the apparent variables, the Kolmogorov-Smirnov statistical test was used (Tabachnick & Fidell, 2005). The SPSS 25.0 statistical software (SPSS Inc., Chicago, IL, USA) was used.

Phase 2: Factorial and Construct Validity and Internal Consistency Testing in the Second Sample

To confirm the factor structure of the IPAQ-SF, a confirmatory factor analysis (CFA) was performed employing the maximum likelihood method (Kline, 2005). Factor loadings that exceeded the criterion of 0.40 were regarded as significant (Kline, 2005). Analysis was conducted by using the AMOS 26.0 statistical software (IBM Corporation, Armonk, NY, USA).

Assessment of model fit was based on the following indexes: (a) the *chi-square* test (χ^2), (b) the Satorra-Bentler χ^2/df ratio, (c) the root mean square error of approximation (*RMSEA*) and (d) standardized root mean square residual (*SRMR*) (Steiger, 1990). Non-significant values of χ^2 and values of χ^2/df ratio smaller than 3.0 indicate an acceptable fit of the model (Kline, 2005). *RMSEA* values lower than 0.05 represent close fit, between 0.05 and 0.08 indicate acceptable fit, whereas *RMSEA* values greater than 0.08 represent poor model fit (Steiger, 1990). *SRMR* values equal to zero indicate perfect model fit. In addition, the assessment of model fit was based on the following comparative/incremental fit indexes: (a) Comparative Fit Index (*CFI*), (b) Goodness of Fit Index (*GFI*), (c) Incremental Fit Index (*IFI*) and (d) Tucker and Lewis Index (*TLI*) (Bentler, 1990; Kline, 2005). *CFI, GFI, IFI* and *TLI* values approximating 1.0 indicate perfect fit, whereas values above 0.90 represent an acceptable fit of the model. However, Hu and

Bentler (1999) supported that values of fit indexes such as 0.95 should be used. Recently, these stringent criteria have been debated (Fan & Sivo, 2005).

Then, the internal consistency of the IPAQ-SF was assessed using Cronbach's *alpha* (α) coefficient. In addition, the construct validity of the IPAQ-SF was examined by applying correlation coefficients among the PA indexes and: (a) Exercise Self-Efficacy Scale, (b) BMI and (c) socio-demographic variables. The hypotheses were that a positive association would be indicated between the IPAQ-SF and exercise self-efficacy, whereas a negative association would be found between PA and age. To further examine the construct validity of the IPAQ-SF, the differences in the PA indexes between men and women were examined by applying *T*-tests for independent samples. To examine the distributions of the apparent variables, the Kolmogorov-Smirnov statistical test was used (Tabachnick & Fidell, 2005).

3. Results

Phase 1: Criterion and Construct Validity Testing

To assess criterion and construct validity, Spearman's correlation coefficients were performed due to the non-normally distributed variables. Specifically, the results indicated positive associations among the weekly PA index of the Godin Leisure-time Exercise Questionnaire and the following PA indexes of the IPAQ-SF: (a) moderate PA index ($r = 0.39$, $p < 0.001$), (b) vigorous PA index ($r = 0.63$, $p < 0.001$) and (c) total PA index ($r = 0.68$, $p < 0.001$). A negative correlation was found between the weekly PA index of the Godin Leisure-time Exercise Questionnaire and sedentary time of the IPAQ-SF ($r = -0.30$, $p < 0.001$). Regarding the control of socially desirable answers, insignificant associations were found among the Social Desirability Scale and the IPAQ-SF PA indexes: (a) walking PA index ($r = 0.07$, $p = 0.48$), (b) moderate PA index ($r = 0.11$, $p = 0.10$), (c) vigorous PA index ($r = -0.08$, $p = 0.40$), (d) total PA index ($r = 0.01$, $p = 0.89$) and (e) sedentary time ($r = 0.02$, $p = 0.84$).

Then the construct validity examination indicated that men ($N = 67$) compared to women ($N = 53$) showed higher vigorous PA values ($t_{(120)} = 3.66$, $p < 0.001$). In contrast, women compared to men revealed higher moderate PA values ($t_{(120)} = -2.66$, $p < 0.001$). Similarly, athletes ($N = 32$) compared to non-athletes ($N = 37$) indicated higher vigorous PA levels ($t_{(69)} = 6.05$, $p < 0.001$) and total PA levels ($t_{(69)} = 4.77$, $p < 0.001$).

Further, age was negatively correlated with both vigorous PA index ($r = -0.50$, $p < 0.001$) and total PA index ($r = -0.40$, $p < 0.001$). In line with the above, negative associations were found among BMI and vigorous PA index ($r = -0.21$, $p < 0.05$) and total PA index ($r = -0.27$, $p < 0.001$). Similarly, sedentary time was negatively correlated with past PA ($r = -0.29$, $p < 0.001$), past sports participation ($r = -0.33$, $p < 0.001$) and present sports participation ($r = -0.38$, $p < 0.001$).

In contrast, the vigorous PA index was positively associated with: (a) past PA ($r = 0.37$, $p < 0.001$), (b) past sports participation ($r = 0.40$, $p < 0.001$) and (c) present sports participation ($r = 0.48$, $p < 0.001$). In addition, the total PA index was positively correlated

with: (a) past PA ($r = 0.40$, $p < 0.001$), (b) past sports participation ($r = 0.38$, $p < 0.001$) and (c) present sports participation ($r = 0.46$, $p < 0.001$). Finally, sedentary time was positively associated with both age ($r = 0.26$, $p < 0.001$) and BMI ($r = 0.32$, $p < 0.001$).

Phase 2: Factorial and Construct Validity and Internal Consistency Testing in the Second Sample

The IPAQ-SF Mardia's coefficient showed multivariate non-normality and CFA was conducted applying bootstrapping with the Bolen-Stine approach (Kline, 2005). The model provided an acceptable fit to the data ($\chi^2 = 1.529$, $p = 0.363$, $df = 2$, $\chi^2/df = 0.765$, $CFI = 0.980$, $GFI = 0.999$, $IFI = 0.983$, $TLI = 0.941$, $RMSEA = 0.022$, $SRMR = 0.017$). The factor loadings values ranged from 0.41 to 0.54, whereas the items' correlations coefficients varied from 0.28 to 0.61. The Cronbach's *a* coefficient was 0.70.

In order to examine the construct validity, Spearman's correlations were performed due to the non-normally distributed variables. Specifically, exercise self-efficacy was positively correlated with the walking PA index ($r = 0.13$, $p < 0.05$), moderate PA index ($r = 0.18$, $p < 0.001$), vigorous PA index ($r = 0.29$, $p < 0.001$) and total PA index ($r = 0.33$, $p < 0.001$). On the other hand, a negative correlation was found between exercise self-efficacy and sedentary time ($r = -0.10$, $p < 0.05$). Furthermore, age was negatively associated with the walking PA index ($r = -0.12$, $p < 0.05$), vigorous PA index ($r = -0.39$, $p < 0.001$) and total PA index ($r = -0.32$, $p < 0.001$), whereas a positive correlation was found between age and sedentary time ($r = 0.16$, $p < 0.001$). In line with this, the number of children was negatively correlated with the vigorous PA index ($r = -0.33$, $p < 0.001$) and total PA index ($r = -0.25$, $p < 0.001$). Finally, men ($N = 209$) compared to women ($N = 517$) showed higher vigorous PA values ($t_{(726)} = 11.70$, $p < 0.001$) and total PA values ($t_{(726)} = 7.02$, $p < 0.001$). In contrast, women compared to men revealed higher moderate PA values ($t_{(726)} = -2.60$, $p < 0.05$).

4. Discussion

The current study examined the criterion, construct and factorial validity of the Greek IPAQ-SF version (Craig et al., 2003) in two independent samples ranging in age from 18 to 65 years old that have not been examined until now. Specifically, the results demonstrated medium to high criterion coefficients for the PA indexes and sedentary time of the IPAQ-SF indicating acceptable criterion validity, except for the walking PA index. This could be attributed to the fact that the Godin Leisure-time Exercise Questionnaire measures mild, moderate and strenuous PA and not walking. A previous study examining the criterion validity of the Greek version of the IPAQ-SF in students using an aerobic exercise test demonstrated medium criterion coefficients for the vigorous and total PA indexes (Papathanasiou et al., 2010). The aforementioned findings are in accordance with those of previous studies investigating the criterion validity of the IPAQ-SF in other populations (Acs et al., 2021; Ekelund et al., 2006; Lee et al., 2011; Tran et al., 2013).

In addition, the current study supported the validity of the Greek version of the IPAQ-SF as an acceptable factor structure was found, which hasn't been examined until now. The current results also indicated higher vigorous and total PA values in men compared to women, which are in accordance with several research findings that demonstrated that women were less physically active than men (Ballegooijen, Ploeg, & Visser, 2019; Choi, Lee, Lee, Kang, & Choi, 2017). However, the present study indicated that women compared to men had higher moderate PA values, which could be possibly explained by a higher level of housework PA among women. This type of PA is included in the moderate PA items of the IPAQ-SF. Finally, the hypothesis of higher PA levels in athletes compared to non-athletes was also confirmed. Therefore, it seems that the IPAQ-SF is a sensitive questionnaire to measure adults' PA levels.

Moreover, exercise self-efficacy, BMI, past PA and socio-demographic characteristics were used to further examine the construct validity of the IPAQ-SF. The results of the current study supported the sensitivity and construct validity of the Greek version of the IPAQ-SF. These findings are in accordance with previous studies demonstrating that exercise self-efficacy (Theodoropoulou, Stavrou, & Karteroliotis, 2017) and past PA (Hirvensalo, Lintunen, & Rantanen, 2000) were positively associated with PA levels, whereas age and BMI were negatively correlated with PA (Ballegooijen et al., 2019). Further support was provided to the current hypothesis by the positive associations among sedentary time of the IPAQ-SF, age and BMI, as well as, the negative correlations among its sedentary time and past PA and sports that were found.

Finally, the Cronbach alpha's coefficient of the IPAQ-SF was acceptable supporting the internal consistency of the instrument, which is in accordance with previous research findings (Lee et al., 2011). Previous studies examining the IPAQ-SF's test-retest reliability demonstrated high test-retest properties (Acs et al., 2021; Craig et al., 2003; Papathanasiou et al., 2009; Tran et al., 2013). The aforementioned results indicated that the IPAQ-SF is a reliable instrument to assess PA levels. Based on the social desirability response biases, the current study demonstrated that participants' responses are not perceived as socially desirable supporting the accuracy and validity of the present results.

However, this study was characterized by several limitations that need to be reported. First, measures were self-reported and measurement issues associated with the common method variance should be considered. Second, objective PA measures were not used to test the criterion validity. Third, there is a memory recall problem in questionnaires and other self-report methods. Despite the apparent limitations, this study had some advantages that should be taken into account. In particular, a key feature of the current study was the investigation of the criterion and factorial validity of the IPAQ-SF in two independent and large samples that have not been examined until now in Greek adults. Furthermore, other important aspects were the investigation of internal consistency, as well as, construct validity both applying differences between groups and examining associations among the IPAQ-SF, exercise self-efficacy perceptions, BMI and various socio-demographic variables.

5. Conclusion

In conclusion, the Greek version of the IPAQ-SF was proven to have acceptable psychometric properties by examining different and large samples of adult participants. This finding indicates that the questionnaire can be used to assess PA participation. Future studies should be carried out to further investigate the validity of the IPAQ-SF using objective measures of PA, such as calorimetry and accelerometers.

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Conflicts of Interest Statement
The authors report there are no competing interests to declare.

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