Bortolozo, E.A.F.Q.; Santos, C.B.; Pilatti, L.A. y Canteri, M.H.G. (2017). Validez del cuestionario internacional de actividad física por correlación con podómetro / Validity of International Questionnaire of Physical Activity by Correlation with Pedometer. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. 17 (66) pp. 397-414. Http://cdeporte.rediris.es/revista/revista66/artcorrelacion811.htm
DOI: https://doi.org/10.15366/rimcafd2017.66.012

## ORIGINAL

# VALIDITY OF INTERNATIONAL QUESTIONNAIRE OF PHYSICAL ACTIVITY THROUGH CORRELATION WITH PEDOMETER

# VALIDEZ DEL CUESTIONARIO INTERNACIONAL DE ACTIVIDAD FÍSICA POR CORRELACIÓN CON PODÓMETRO

**Bortolozo, E.A.F.Q.[1]; Santos, C.B.[2]; Pilatti, L.A.[3] & Canteri, M H.G.[4]**

[1] Bachelor of Nutrition. Master's degree in pharmaceutical sciences by the Federal University of Paraná; Doctoral in Production Engineering by the Federal Technological University of Paraná. Mail: bortolozopg@gmail.com

[2] Bachelor of Physical Education. Doctoral in Production Engineering by the Federal Technological University of Paraná, Brazil.Mail: bilynkievycz@globo.com

[3] Bachelor of Physical Education. Doctor in Physical Education. Research Productivity CNPq. Professor of Production Engineering Program of the Federal Technological University of Paraná, Ponta Grossa, Brasil. Mail: lapilatti@utfpr.edu.br

[4] Bachelor of Pharmacy and Biochemistry. Master and PhD in Food Technology from the Federal University of Paraná. Doctor in Sciences by the Université Agronomiques d'Avignon et Pays de Vaucluse. Professor of Department of Food and Graduate Program in Production Engineering from the Federal Technological University of Paraná, Ponta Grossa, Brazil. Mail: canteri.mhg@gmail.com

**Spanish-English translator:** Victor Gutiérrez Martínez victor@idiomasleon.es

**ACKNOWLEDGEMENTS**

Thank CAPES for financial investment in the form of scholarship in Program Production Engineering from the Federal Technological University of Paraná.

**Código UNESCO / UNESCO code:** 3212 Salud Pública / Public Health, 3206
**Clasificación Consejo de Europa / Council of Europe classification**: 17. Otras: Actividad Física y Salud / Other: Physical Activity and Health

**Recibido** 29 de octubre de 2014 **Reveived** October 29, 2014
**Aceptado** 2 de marzo de 2015 **Accepted** March2, 2015

## ABSTRACT

The goal of this study is to verify the validity of the International Physical Activity Questionnaire (IPAQ) through correlation with another instrument to measure energy expenditure (EE) and level of physical activity (PAL). The data was analyzed using correlation and data mining. Significant correlations ($p<0.001$) were observed for the number of steps with calories ($r=0.76$; 0.80) and the rating scale of PAL ($r=0.93$; 0.71), involving the pedometer and the IPAQ, respectively. The same occurred between the number of calories ($r=0.83$) and scale ($r=0.67$), for the same procedures. A high correlation was found between the use of the IPAQ (long version) and the pedometer, resulting in classification models with a degree of prediction of up to 84.10% ($r=0.917$) of the dependent variable, with the ability to predict EE and PAL through the IPAQ from the number of steps measured by the pedometer.


**KEYWORDS**: International Physical Activity Questionnaire (IPAQ); pedometer; energy expenditure; physical activity.

**RESUMEN**

El estudio tiene por objetivo verificar la validez del Cuestionario Internacional de Actividad Física (IPAQ) por medio de correlación con otro instrumento de medida de gasto energético (GE) y nivel de actividad física (NAF). Los datos fueron analizados por medio del teste de correlación y técnicas de *Data Mining*. Fueran observadas correlaciones significativas (p<0,001) de los números de pasos con las calorías (r=0,76; 0,80) y escala de clasificación de NAF (r=0,93; 0,71), involucrando respectivamente el Podómetro y el IPAQ. Lo mismo ha sucedido entre el número de calorías (r=0.83) y escala (r=0,67), por los mismos procedimientos. Se ha constatado elevada correlación entre el IPAQ y el podómetro, resultando en modelos de clasificación con grado de predicción de hasta 84,10% (r=0,917) de la variable dependiente, con capacidad de predicción del GE y NAF a través del IPAQ, con base en el número de pasos mensurados por el podómetro.

**PALABRAS CLAVE**: Cuestionario Internacional de Actividad Física (IPAQ). Podómetro. Gasto energético. Actividad física.

## INTRODUCTION

Chronic non-communicable diseases (CNCDs) such as obesity, diabetes and cardiovascular disease account for 60% of the causes of mortality in the world. That death rate in low-income countries can even rise to reach 80%[1]. It is thus undoubtedly necessary, faced with such a critical situation, to evaluate risk factors like the performance of physical activity (PA) in order to ensure an environment-based monitoring of the development of these diseases[2].

The change of life style caused by urbanisation, industrialisation and technological progress has resulted in the reduction of energy expenditure (EE) during different daily activities in the workplace, in the use of transport or even at leisure times, which, in turn, leads to a more sedentary lifestyle and a growing prevalence of obesity and other degenerative diseases[3,4,5].

The literature in this field points out the correlation between the level of physical activity (LPA) and the increased body mass index (BMI), waist circumference, diastolic blood pressure and carotid artery thickness[6,7,8,9]. Similarly, increased PA can be linked to a reduced risk of suffering different diseases including high blood pressure, coronary heart disease, cerebrovascular accidents and insulin resistance[10,11].

In order to keep healthy, fit adults aged 18 - 65 have to practise either moderate aerobic PA (endurance) during a minimum period of 30 minutes five days every week or more intense aerobic activity during a minimum period of 20 minutes three days per week[12,13].

Total energy expenditure (EE) refers to three components: basal metabolic rate (BMR), thermic effect of food (TEF) and energy expenditure during physical activity (EEPA), the latter of which being the greatest source of variation. One's body mass is another item that needs to be considered when evaluating the amount of burnt off calories, particularly according to movement[14].

With regard to the identification of risk factors for (CNCDs) while taking EE and LPA into account, different methods are used either in the clinic or during the field study. The choice depends on the number of people who are to be monitored, the cost of the procedure and the inclusion of different ages. They are classified as physiological indicators: calorimetry, motion sensors and anamnesis tools. The first ones are more reliable, expensive and complex whereas the last two present more operational and economic viability[15,16].

The anamnesis questionnaires are low-cost instruments that are based on recalling and self-reporting such as the International Physical Activity Questionnaire (IPAQ) in both long and short versions about work, transport, household chores and leisure. The IPAQ was first suggested by a group of participants of a scientific meeting held in Geneva/Switzerland in 1998 and was later validated in twelve countries[15,17,18]. Despite being widely used, it is, if compared with objective measurement instruments, undermined by restrictions regarding the possible inaccuracy of the information and smaller correlations given by the respondents[19,20]. In addition, the IPAQ has been used more for the classification of the LPA and, to a lesser extent, for the estimation of the EEPA.

Since the IPAQ may overestimate or underestimate the results of EEPA and inactivity rates, it should be used in conjunction with a motion instrument like pedometers or accelerometers[21,22]. According to Basset Jr[23], the pedometer can be suggested as measurement criterium in order to validate the issue related to the covered distance in case LPA reminders are applied.

The pedometer, energy expenditure measurement tool, consist of a motion sensor which monitor the number of steps per day. It has a low cost if compared with other devices such as heart rate monitors or accelerometers[24]. Its use has proved effective according to its quick response for the measurement of the covered distance and burnt off calories. However, it has some restrictions such as the lack of evaluation of  the intensity and tempo of the activity[24]. Similarly, it has frequently been selected as walk measuring device and in the evaluation of intervention programmes while its applicability to identify LPA and EE during common everyday physical activities is less obvious.

Investigations for the research into LPA or for the evaluation of intervention programmes have used the IPAQ together with the pedometer as a protocol to reduce error in the diagnosis[26,27]. However, since many studies found a low correlation between LPA estimates when comparing the results obtained through self-reporting questionnaires and measurement tools such as the pedometer[28,29], news studies for the validation of the IPAQ and correlations with the pedometer are justified.

Taking into account the importance of the accurate LPA diagnosis as subsidy for the implementation of CNCDs monitoring preventive measures among the population: also in order to monitor its effectiveness, this study aims to verify the validity of the IPAQ through the correlation with another energy expenditure measurement tool and LPA apart from suggesting a prediction model using classification Data Mining techniques.

## MATERIAL AND METHODS

*Sample*

It is an observational study with cross sectional delineation involving the participation of 118 adults from both sexes who work in the industry sector of the municipality of Ponta Grossa in Paraná (Brazil) and who complied with the following norms: aged between 18 and 55 years, minimum level of 5th year of elementary education and linked to the industry sector.

The sample size has been determined according to Triola's[30] proposal using the equation (n=1,96 x deviation-standard/error). A standard deviation of 3,430 and a margin of error of 650 have been considered based on the preceding result[31]. With a significance level of 0,05, the minimum sample size would be 170 participants.

*Recruitment and Procedures*

Following the approval for the study from the Human Research Committee of the Federal Technological University of Paraná (CAAE: 14331813.0.0000.5547 - 361.283) and the invitation, the objectives of the research were presented and explained. The participants who willingly decided to take part in the study and complied with the admission requirements signed a free prior and informed consent document.

Participants were individually interviewed in order to collect personal (age and gender) and anthropometric (mass and height) data. The anthropometric measurements (mass and height) were calibrated according to the protocol by Onis et al[32]. In order to verify Quetelet index or Body Mass Index (BMI), the subject's body mass in kilos has been divided by the square of their height in metres[33]. The nutritional status classification was performed based on the BMI according to the World Health Organisation requirements. The participants were classified as lean mass (BMI < 18,5kg/$m^2$), eutrophic (BMI between 18,5-24,9kg/ $m^2$), overweight (BMI between 25,0-29,9kg/ $m^2$) and obese (BMI ≥30,0kg/ $m^2$)[34].

*IPAQ procedures*

The IPAQ long version 8, adapted to the Brazilian population[17], was applied based on information that was obtained in individual, structured and standardised interviews with the same procedure being maintained with all the interviewees. The IPAQ allows the measurement of the metabolic equivalent MET of the physical activities in terms of work, transport, housework and leisure. Therefore, the time (in minutes) spent has been multiplied by a constant referring to activity and variable according to values suggested by Heymsfield[35] and Ainsworth[36] (Table 1). The overall estimate was obtained through the sum of the scores of each domain.

**Table 1**: Metabolic equivalent MET in different variables of the International Quality of Life Questionnaire.

| Domain | Activity | MET |
|---|---|---|
| Work | Walking | 3.3 |
| | Moderate activity | 4.0 |
| | Vigorous activity | 8.0 |
| Transport | Walking | 3.3 |
| | Cycling | 6.0 |
| Domestic activity | Moderate (at home) | 3.3 |
| | Moderate (outside the home) | 4.0 |
| | Vigorous | 5.5 |
| Leisure | Walking | 3.3 |
| | Moderate | 4.0 |
| | Vigorous | 8.0 |

Source: adaptation from Heymsfield[35]: Ainsworth[36]

In order to determine the calorie expenditure of PA in kilocalories (kcal), the total value of MET was multiplied by the body mass in kgs and by the duration in hours of the PA (MET x body mass in kgs x duration in hours)[35,36]. The ideal mass was considered based on the BMI = 22 $kg/m^2$.

For the classification of the level of PA, considering the results from the IPAQ, the total value of PA was estimated in minutes per week including walking, moderate and vigorous activities. The participants were classified into the following levels: highly physically active, active, irregularly active and sedentary according to the model suggested by the IPAQ Coordination Centre in Brazil[15].

*Procedures for monitoring movements with the pedometer*

The monitoring with the pedometer (*Yamax Gigi Walker* SW – 700) was performed in 5 consecutive days, considering the period going from the beginning of work activities on the first day until the end of the work day on the fifth day. The device was conveniently adjusted on the waist of the volunteer by means of a woollen string at the hips. Each participant received prior personalised training and a sheet to write down the times and days of use as well as the total number of steps recorded by the device. The results were obtained in kcal according to the number of steps and mass if the participant with an average value of 0,55 kcal/kg/step.

The participants were classified into four categories of level of PA, taking the daily average number of steps into account: sedentary and low activity (<7.499 steps); not very active (7.500-9.999 steps); active (10.000-12.499 steps) and highly active: ≥ 12.500 steps)[31].

*Statistical and Data Mining procedures*

The data of the numerical variables were subjected to the Kolmogorov-Smirnov test for normality indicating the use of Pearson parametric correlation coefficient test. The categorical and numerical variables were subjected to Data Mining techniques in a process known as Knowledge Discovery in Databases (KDD)[37] through the WEKA data mining software with a level of significance of 95%.

The dimensionality reduction in the stage prior to the Data Mining process was based on Feature Selection Algorithms between CFS and Relief-F Attribute Evaluation[39,40,41].

In order to solve KDD-based prediction and description problems, Data Mining Classification techniques and Association Rules were used respectively. Classification techniques through decision tree algorithms were applied: Quinlan's[42,43] M5P algorithms implemented by Wang and Witten[44]. The Association Rules technique through the A Priori algorithm, developed by Agrawal and Srikanth[45], adapted and expanded by Ma[46], was applied.

For the study of the classification correlation of the level of PA, based on the IPAQ and the pedometer, the different classes were determined according to the following scale: sedentary and low activity (1 point); not very active or irregularly active (2 points); active (3 points); highly active or very active (4 points).

## RESULTS

The average age of the participants was 33 years (±10,13) for men and 30 years (±10,01) for women. The proportion between the genders has reached 72,2% of men (n=86) and 27,72 % of women (n=33).

In connection with the BMI, the average was 26,61 $m^2$ (± 4,85) for men and 25,61 $m^2$ (± 5,25) for women; no significant difference between the genders was noticed ($p>0,05$). Nevertheless, as regards overweight, the average BMI values showed a 31,0% prevalence among women and a 42,0% among men. 16,0% of the women were considered obese against 19,0% of men.

Table 2 presents the descriptive statistics of the data referring to the number of steps and calories calibrated through the pedometer and the IPAQ.

**Table 2**: Descriptive statistics of the number of steps and calorie expenditure obtained through the pedometer and International Physical Activity Questionnaire in adults, Ponta Gossa, Paraná, Brazil, 2014.

| Descriptive Statistics Overview (n=118) | *Steps* | Calories | | Scale* | |
|---|---|---|---|---|---|
| | | *Pedometer* | *IPAQ* | *Pedometer* | *IPAQ* |
| Average | 11411.31 | 583.81 | 657.81 | 2.30 | 2.64 |
| Standard Deviation | 6253.71 | 419.34 | 545.05 | 1.14 | 0.83 |
| Minimum | 609 | 72 | 0 | 1 | 1 |
| Maximum | 26403.00 | 3069.00 | 2337.20 | 4.00 | 4.00 |

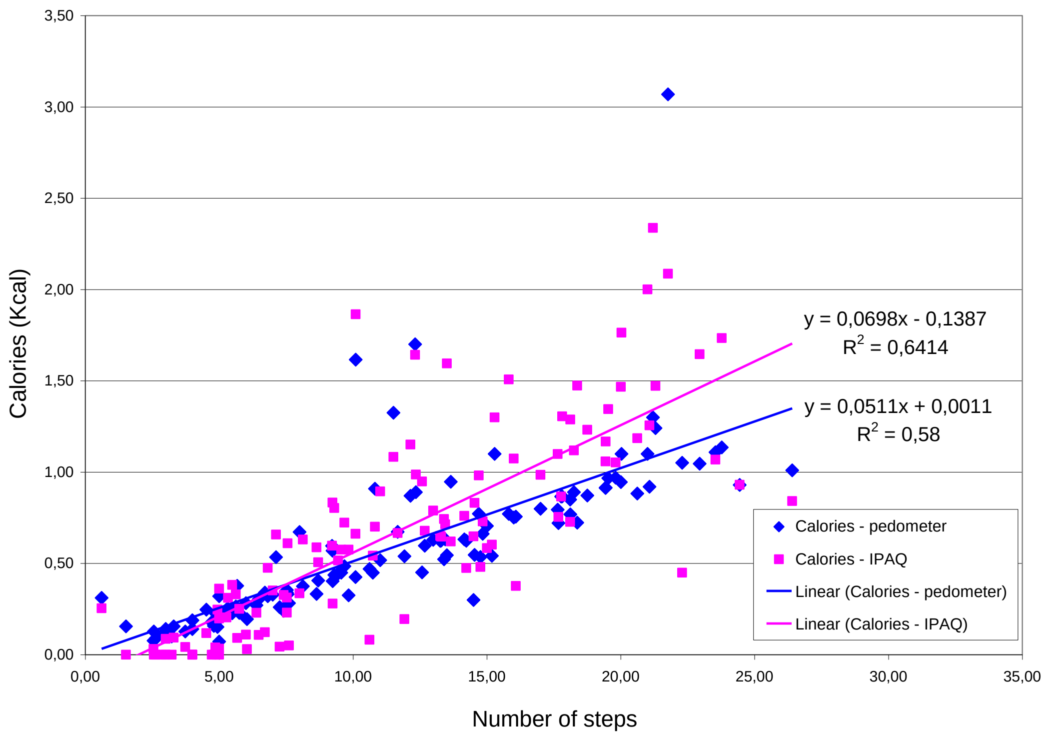
*sedentary and low activity (1 point); not very active or irregularly active (2 points); active (3 points); highly active or very active (4 points)

The table 3 shows strong (r >0,6) and significant (p<0,001) correlations between the number of steps and calories (r=0,76; 0,80) and scales (r=0,93; 0,71) involving the pedometer and the IPAQ respectively: and between the amount of calories (r=0.83) and the scales (r=0,67) through the same methods.

**Table 3** - Correlation between variables: Number of steps x Calories x Steps

| Pearson Correlation (p<0.001) | | | Number of steps | Calories | | Scales of PAL | |
|---|---|---|---|---|---|---|---|
| | | | | ***Pedometer*** | ***IPAQ*** | ***Pedometer*** | ***IPAQ*** |
| Number of steps | | | 1 | | | | |
| Calories | ***Pedometer*** | 0.76 | 0.76 | 1 | | | |
| | ***IPAQ*** | 0.80 | 0.80 | 0.83 | 1 | | |
| Scale of PAL | ***Pedometer*** | 0.93 | 0.90 | 0.70 | 0.76 | 1 | |
| | ***IPAQ*** | 0.71 | 0.68 | 0.68 | 0.76 | 0.67 | 1 |

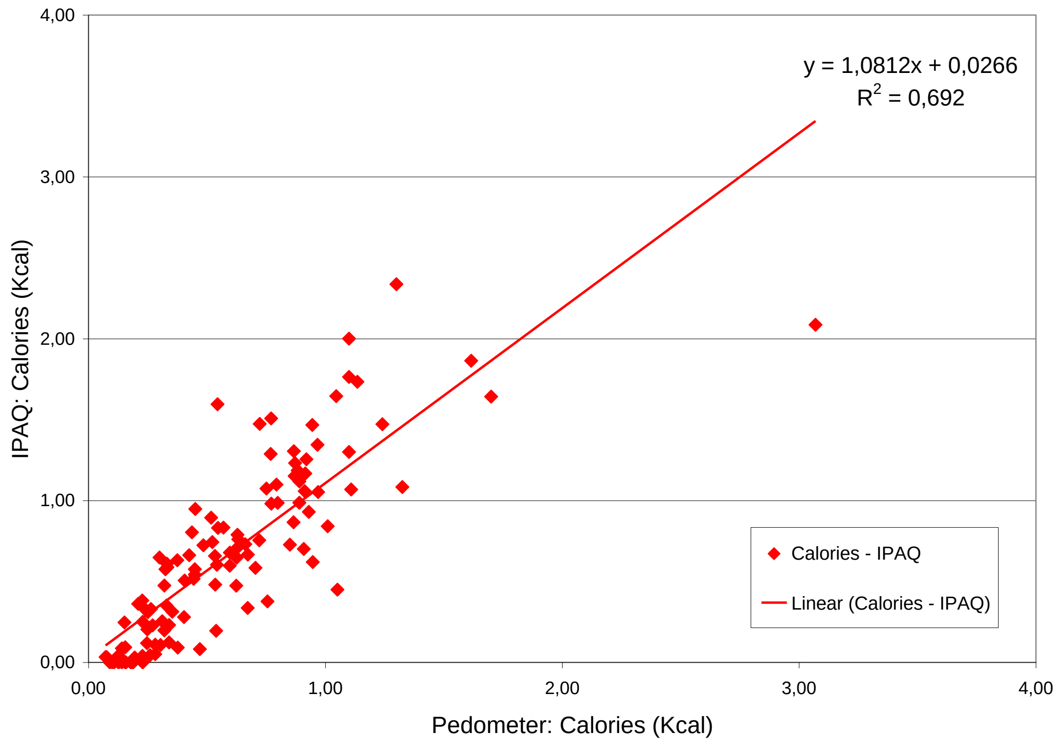
Figure 1 shows two linear regression models for the prediction of calories based on the number of steps. The estimated values by the pedometer referring to the consumption of calories presented a coefficient of determination of 58% ($R^2$=0,58) through the following equation: y = 0,0511x + 1,0703). It is possible to predict, based on the equation: y = 0,0698x – 138,72, the burnt-off calories with a 64,14% capacity to explain the variance of the dependent variable ($R^2$=0,6414).




Note: coordinate x = independent variable; coordinate y = dependent variable

**Figura 1** - Correlation between the Number of Steps and Calories (kcal)

Figure 2 presents a linear regression model for the prediction of calories (dependent variable) for the IPAQ based on the results of the caloric expenditure registered by the pedometer with a determination coefficient of 69.20% of the dependent variable.




Note: coordinate x = independent variable; coordinate y = dependent variable

**Figure 2** - Correlation between calorie values obtained through the pedometer and IPAQ

The IPAQ equation (calorie) = 0,0347 * Steps + 0,6868 * pedometer (calorie) – 139,459 presents the classification model for the prediction of IPAQ values using Data Mining classification techniques through the M5P algorithm. As regards the development of the model, 66,67% of the registers for training 33,33% for testing were used, resulting in a model with greater predictive capacity than the previous ones (r = 0,917).

The data were categorized based on the level of PA in the procedures used (Pedometer and IPAQ) and, shortly afterwards, subjected to different Feature Selection Algorithms used during the stage prior to the processing of Data Mining, contained in the KDD Process, through the WEKA Software. The following variable was established as goal-attribute: “Class of IPAQ”, removing the following variables from the database: “Scale of IPAQ" and “Calories of IPAQ”, in which the goal-attribute held functional dependence (Table 3). Figure 3 presents the ranking by algorithms, considering the results assigned for the classes of level of PA of the different procedures. The results were organized in a scale of 0-1, considering values close to 1 for the attributes with best rank by degree of prediction.

**Table 4** - Classification of the Level of PA and Equivalence between the scales

| | Selection of attributes | Predictor Attributes | | | | |
|---|---|---|---|---|---|---|
| | | Pedometer | | | | |
| | | Number of steps | Calorie | Class | Scale | |
| Algorithms | *ChiSquaredAttributeEval* | 3rd | 1st | 2nd | 4th | Target attribute |
| | *ClassifierAttributeEval :(OneR)* | 3rd | 1st | 2nd | 4th | |
| | *CorrelationAttributeEval* | 1st | 3rd | 4th | 2nd | |
| | *GainRatiAttributeEval* | 1st | 2nd | 3rd | 4th | |
| | *InfGainAttributeEval* | 3rd | 1st | 2nd | 4th | |
| | *OneRAttributeEval* | 2nd | 1st | 3rd | 4th | |
| | *SignificanceAttributeEval* | 2nd | 1st | 3rd | 5th | |
| | *ReliefFAttributeEval* | 3rd | 4th | 1st | 2nd | |
| | *SymmetricalUncertAttributeEval* | 2nd | 1st | 3rd | 4th | |

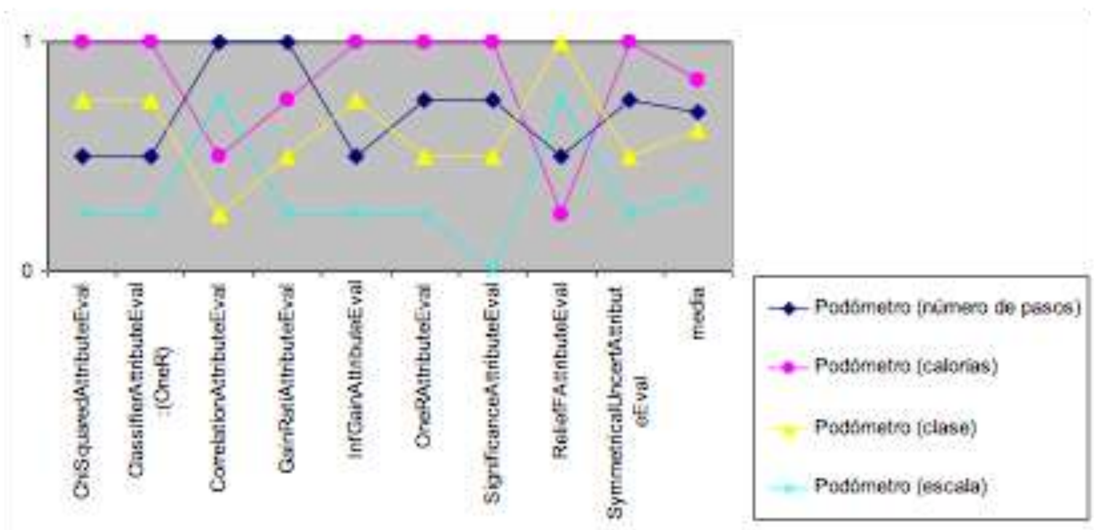



**Figure 3**- Rank per algorithm and median value of variables from pedometer according to the degree of prediction of the classes of the IPAQ

Following the observation about the prediction possibility of the classes of the IPAQ based on the variables from the pedometer, various models were developed through the J48[39] algorithm including the one appearing in Figure 4 with the highest accuracy rate. The model presents the Level of PA (LPA) as the predictor attribute through the pedometer with a coefficient of accuracy of 77,5 % and Kappa statistic = 0,5799, considered moderate and more precise for the classification of classes: Active (88%) and Sedentary (100%).

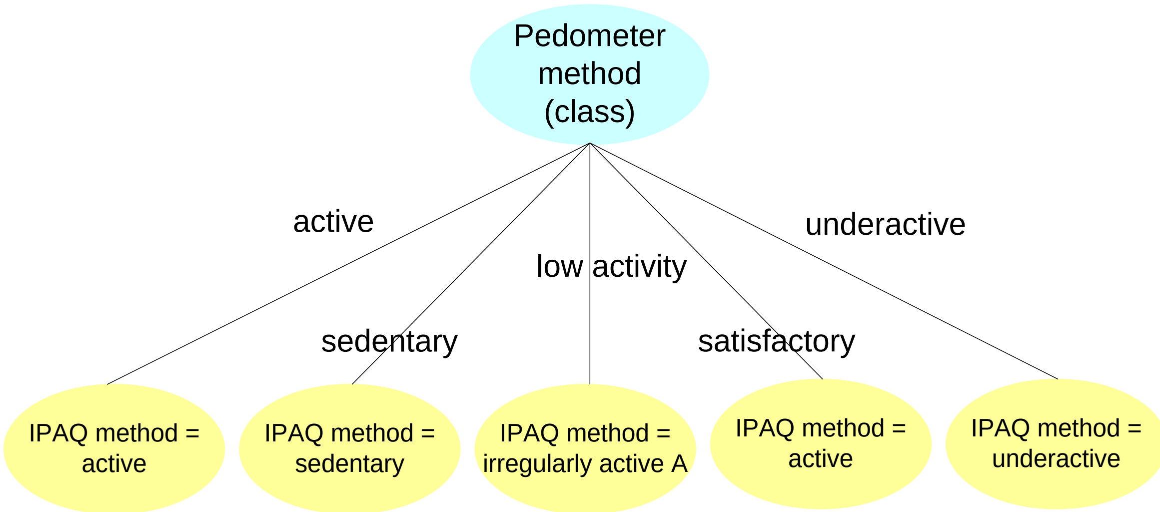
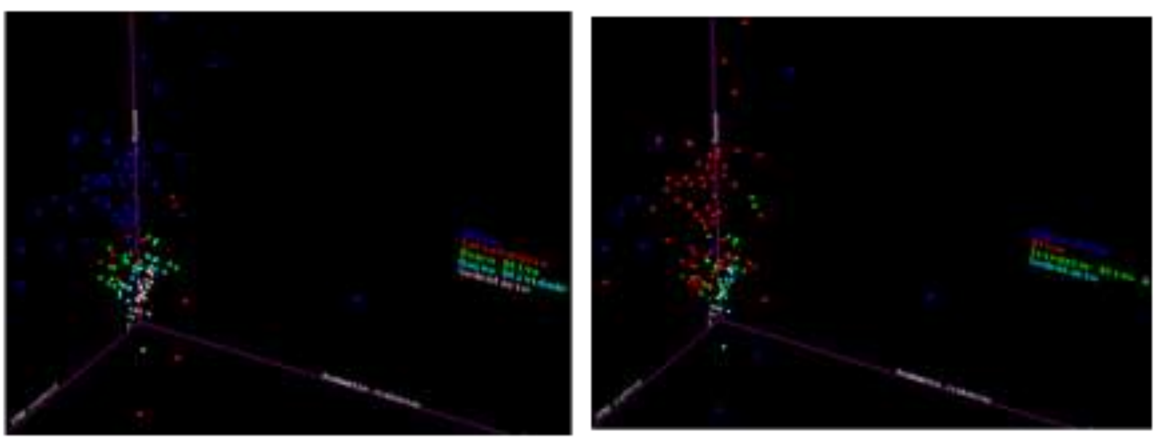



**Figure 4** - Classification Model for the prediction of classes of IPAQ

Based on information found in the previous models, the involved variables were represented in a 3D model in the WEKA data display environment (Figure 5).



Note: (a) Classification through the pedometer (b) Classification through the IPAQ

**Figure 5** - 3D representation model of the classification of LPA with the variables on the axis: X - pedometer (calorie), y - pedometer (number of steps), z: IPAQ (calories)

Chart 1 shows the association between the variables categorized with the Data Mining technique of Association Rules using the A priori algorithm. Based on the Association Rules (RA 2 and RA 4), we notice that the classes “Not very Active" or "Active" in the pedometer classes correspond to class “Active" of the IPAQ with 82,09% confidence, considering the supports of each of these rules. The class “Active", based on the pedometer, also corresponds to the same class of the IPAQ, with 84% confidence (RA 3). The class “Sedentary" presents the same equivalence in the procedures with 75% confidence (RA 5).

1. IPAQ (class)=sedentary 16 ==> Pedometer (class)=sedentary 15
   <conf:(0.94)> lift:(5.53) lev:(0.1) [12] conv:(6.64)
2. Pedometer (class)=active 50 ==> **IPAQ (class)=Active 42**
   <conf:(0.84)> lift:(1.42) lev:(0.1) [12] conv:(2.26)
3. IPAQ (class)=very active 10 ==> Pedometer (class)=active 8
   <conf:(0.8)> lift:(1.89) lev:(0.03) [3] conv:(1.92)
4. Pedometer (class)=underactive 17 ==> **IPAQ (class)=active 13**
   <conf:(0.76)> lift:(1.29) lev:(0.02) [2] conv:(1.38)
5. Pedometer (class)=sedentary 20 ==> **IPAQ (class)=sedentary 15**
   <conf:(0.75)> lift:(5.53) lev:(0.1) [12] conv:(2.88)

**Chart 1**- Association Rules between the classes of the pedometer and IPAQ

## DISCUSSION

The current study analyzed the correlation between the pedometer and the IPAQ (long version) in order to determine the Level of Physical Activity (LPA) and Energy Expenditure (EE) among the workers involved in the research. Statistical and Data Mining techniques techniques were used in order to correlate the variables involved in the research using numerical and categorical data.

The group that was evaluated consists of young people, from both sexes with the majority being males since there is a greater concentration of men within the industrial sector.

A high predominance of people with overweight and obesity in both sexes was noticed. Such a result is similar to that of other studies in which a similar tendency between workers is observed[3,5].

The average number of steps made by the workers under evaluation showed a prevalence of moderate and vigorous activity as 10,000 daily steps represent a reasonable goal for the promotion of health in healthy adults[31]. Such a result is similar to that obtained in studies by Cocker et al.[26], who identified, among monitored adults, 22,6% not very active, 18,7% active and 39,4% highly active. On the other hand, the average value observed in that study is over that observed by Dwyer et al.[9] and by Basset Jr. et al.[47].

In order to determine energy expenditure (EE), a high positive correlation ($r>0,6$; $p<0,001$) was identified between the estimated values for the pedometer ($R^2=0,58$) and IPAQ ($R^2=0,64$) based on the number of steps. The identification of PA habits based on self-report stands out as one of the inconveniences of the IPAQ[19,27,29]. Pardini et al.[48]; Clark et al[28]. and Kim et al.[29] found a low correlation between the IPAQ and the motion sensors. Benedetti et al.[49] found a Spearman correlation from moderate to low between the values obtained through the IPAQ and the pedometer ($r=0,24$).

Possibly, the type of approach used in this study proved its capacity to minimise the comprehension and response difficulty for the different items of the IPAQ.

The correlation between both procedures for the evaluation of EE and LPA was an important discovery. Studies carried out by Cocker et al[26]. and Tudor-Locke et al.[50] also positively correlated the classification of LPA based on the number of steps and the subjective data from the IPAQ (long version). The study of Welk et al.[24] pointed out a positive correlation between the pedometer and the IPAQQ, regarding the number of steps, to evaluate whether the participants perform at least 30 minutes of daily PA.

The techniques used in this study are research methods, which are more viable for the analysis aimed at determining the needs and energy balances of the population, considering their low-cost and more rapid application.

The decision tree model presents the prediction of the classes of the IPAQ based on the classes of the pedometer with a high accuracy rate (77,5%), mainly when predicting the categories "sedentary" (100%) and "active" (88%), cutting lines for the diagnosis of PA habits[50].

## CONCLUSION

Although the pedometer did not discriminate the intensity of PA, those pieces of equipment provided enough information for the identification of habits of low LPA or sedentarism.

The study showed a significant correlation between the values of energy expenditure and the classification of LPA obtained though the IPAQ (long version) and through the pedometer with the possibility of predicting more variables that are difficult to collect thanks to the use of that of better accessibility. Both procedure under scrutiny, the pedometer and IPAQ, can be used either to provide data referring to the LPA or to indicate the average value of energy expenditure (EE).

The high correlation and prediction observed in this study allow for the feasibility of population studies including the Level of Physical Activity (LPA) and Energy Expenditure in Physical Activity (EEPA) and using at least one of the methods.

The use of Data Mining techniques proved useful for the development of description and prediction models. Both the statistical Data Mining techniques pointed out models with the capacity of predicting the variables of an instrument through the variables of another less accessible instrument.

## REFERENCES

1 World Health Organization (WHO). 2008-2013 Action Plan for the global strategy for the prevention and control of non-communicable diseases. [Consultado 2012 febrero 5]. Disponible en: http://whqlibdoc.who.int/publications/2009/9789241597418_eng.pdf.

2 Ribeiro AG, Cotta RMM, Ribeiro SMR. A promoção da saúde e a prevenção primária integrada dos fatores de risco para doenças cardiovasculares. Ciência & Saúde Coletiva 2012; 17(1):7-17. https://doi.org/10.1590/S1413-81232012000100002

3 Allman-Farinelli MA, Chey T, Merom D, Bauman AE. Research Occupational risk of overweight and obesity: an analysis of the Australian Health Survey. Journal of Occupational Medicine and Toxicology 2010; 5 (14): 1-9.

4 Kushi LH, Doyle C, McCullough M, Rock CL, Demark-Wahnefried W, Bandera EV, Gansler T. American Cancer Society guidelines on nutrition and physical activity for cancer prevention. CA: A Cancer Journal for Clinicians 2012; 62(1): 30-67. https://doi.org/10.3322/caac.20140

5 Chau J, Van der Ploeg HP, Merom D, Chey T, Bauman AE. Cross-sectional associations between occupational and leisure-time sitting, physical activity and obesity in working adults. Preventive Medicine 2012; 54(3): 195-200. https://doi.org/10.1016/j.ypmed.2011.12.020

6 Bastos, AA, González Boto R, Molinero González O. y Salguero del Valle A. Obesidad, nutrición y Actividad Física. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte 2005; 5(18):140-153.

7 Mitsui T, Shimaoka K, Tsuzuku S, Kajioka, T, Sakakibara H. Pedometer-determined physical activity and indicators of health in Japanese adults. Journal of Physiological Anthropology 2008; 27(4): 179-184. https://doi.org/10.2114/jpa2.27.179

8 Kozàkovà M, Palombo C, Morizzo C, Nolan JJ, Konrad T, Balkau B. Effect of sedentary behaviour and vigorous physical activity on segment-specific carotid wall thickness and its progression in a healthy population. European Heart Journal 2010; 31(12):1511-1519. https://doi.org/10.1093/eurheartj/ehq092

9 Dwyer T, Ponsonby AL, Ukoumunne OC, Pezic A, Venn A, Dunstan, DJ. Association of change in daily step count over five years with insulin sensitivity and adiposity: population based cohort study. BMJ 2011; 342: 1-8. https://doi.org/10.1136/bmj.c7249

10 Alevizos A, Lentzas J, Kokkoris S, Mariolis A, Korantzopoulos P. Physical activity and stroke risk. International journal of clinical practice 2005; 59(8): 922-930. https://doi.org/10.1111/j.1742-1241.2005.00536.x

11 Kohl HW, Craig CL, Lambert EV, Inoue S, Alkandari JR, Leetongin G, Kahlmeier S. The pandemic of physical inactivity: global action for public health. The Lancet 2012; 380(9838):294–305. https://doi.org/10.1016/S0140-6736(12)60898-8

12 Braith RW, Stewart KS. Resistance exercise training. It prevention of cardiovascular role in the prevention of cardiovascular disease. Circulation 2006; 113(22): 2642-2650. https://doi.org/10.1161/CIRCULATIONAHA.105.584060

13 World Health Organization (WHO) (2010). Globalysical activity for the World Health. Geneva: WHO Library. [consultado 5 febrero 2012]. Disponible en: http:// whglibdoc.who. int/publications/ 2010/9789241599979.eng.pdf
14 Montoye H, Kemper H, Saris W, Washburn R. Measuring Physical Activity and Energy Expenditure. Illinois: Human Kinetics, 1996.
15 Matsudo S, Araújo T, Matsudo V, Andrade D, Andrade E, Braggion G. Questionário Internacional de Atividade Física (IPAQ): Estudo de Validade e Reprodutibilidade no Brasil. Atividade Física e Saúde 2001; 6(2): 5-18.
16 Haskell W., Lee IM, Pate RR. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Medicine and science in sports and exercise 2007; 39(8):1423-1434. https://doi.org/10.1249/mss.0b013e3180616b27
17 Armstrong T, Bull F. Development of the world health organization global physical activity questionnaire (GPAQ). Journal of Public Health 2006; 14:66-70. https://doi.org/10.1007/s10389-006-0024-x
18 Bauman A, Bull F, Chey T, Craig CL, Ainsworth BE, Sallis JF, Pratt, M**.** The International Prevalence Study on Physical Activity: results from 20 countries. International Journal of Behavioral Nutrition and Physical Activity 2009; 6**(**21):1-11. https://doi.org/10.1186/1479-5868-6-21
19 Lima RA, Freitas CMSMD, Smethurst WS, Santos CM, Barros, MVGD. Nível de atividade física em idosos com doença de Alzheimer, mediante aplicação do IPAQ e de pedômetros. Revista Brasileira de Atividade Física & Saúde 2012; 15(3): 180-185.
20 Vespasiano BDS, Dias R, Correa, DA. A utilização do Questionário Internacional de Atividade Física (IPAQ) como ferramenta diagnóstica do nível de aptidão física: uma revisão no Brasil. Saúde em Revista 2012; 12(32): 49-54. https://doi.org/10.15600/2238-1244/sr.v12n32p49-54
21 Prince S, Adamo K, Hamel M, Hardt J, Gorber S, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. International Journal of Behavioral Nutrition and Physical Activity 2008; 5(1): 56. https://doi.org/10.1186/1479-5868-5-56
22 Cafruni CB, Valadão RDCD, de Mello ED. Como Avaliar a Atividade Física? Revista Brasileira de Ciências da Saúde 2012, 10(33), 61-71. https://doi.org/10.13037/rbcs.vol10n33.1555
23 Bassett Jr, D.R (2000). Validity and reliability issues in objective monitoring of physical activity. Research Quarterly for Exercise and Sport, 71(2): 30-36. https://doi.org/10.1080/02701367.2000.11082783
24 Welk GJ, Differding JA, Thompson RW, Blair SN, Dziura J, Hart, P. The utility of the Digi-walker step counter to assess daily physical activity patterns. Medicine and Science in Sports and Exercise 2000; 32(9): S481-S488. https://doi.org/10.1097/00005768-200009001-00007
25 Kang M, Marshall SJ, Barreira TV, Lee, JO. Effect of pedometer-based physical activity interventions: a meta-analysis. Research quarterly for exercise and sport 2009; 80(3): 648-655. https://doi.org/10.1080/02701367.2009.10599604
26 Cocker KA, De Bourdeaudhuij IM, Cardon GM. The effect of a multi-strategy workplace physical activity intervention promoting pedometer use and step count

increase. Health education research 2010; 25(4): 608-619. https://doi.org/10.1093/her/cyp052
27 Schmidt MD, Cleland VJ, Thomson RJ, Dwyer T, Venn AJ. A comparison of subjective and objective measures of physical activity and fitness in identifying associations with cardiometabolic risk factors. Annals of epidemiology 2008; 18(5): 378-386. https://doi.org/10.1016/j.annepidem.2008.01.005
28 Clark BK, Thorp AA, Winkler EA, Gardiner PA, Healy GN, Owen N, Dunstan DW. Validity of self-reported measures of workplace sitting time and breaks in sitting time. Medicine and Science in Sports and Exercise 2011; 43(10): 1907-1912.
29 Kim Y, Park I, Kang M. Convergent validity of the international physical activity questionnaire (IPAQ): meta-analysis. Public health nutrition 2013; 16(03): 440-452. https://doi.org/10.1017/S1368980012002996
30 Triola MF. Introdução à estatística (10ª ed.). Rio de Janeiro: LTC, 2008.
31 Tudor-Locke C, Hatano Y, Pangrazi RP, Kang, M. Revisiting How Many Steps are Enough? Medicine and science in sports and exercise 2008; 40(7): S537. https://doi.org/10.1249/MSS.0b013e31817c7133
32 Onis M, Onyango AW, Van den Broeck J, Chumlea WC, Martorell R. Measurement and standardization protocols for canthropometry used in the construction of a new international growth reference. Food and Nutrition Bulletin 2004; 25(1): S15-S26.
33 International Lipid Information Bureau (ILIB) Latino América. Recomendaciones de ILIB para el diagnóstico de las dislipidemias en Latino América. Cardiovasc. Risk Factors 1994; 3(1): S10-S27.
34 World Health Organization (WHO) (2000). Obesity: preventing and managing the global epidemic. Geneva: WHO Technical Report Series. [consultado 5 febrero 2012]. Disponible en: http://www.who.int/nutrition/publications/obesity/WHO_TRS_894/en/
35 Heymsfield SL, Lohman T, Wang Z, Going S. Human Body Composition. Ed. Champaign, Human Kinetics, 2005.
36 Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR, Tudor-Locke C, Leon AS. 2011 compendium of physical activities: a second update of codes and MET values. Medicine and Science in Sports and Exercise 2011; 43(8): 1575-1581. https://doi.org/10.1249/MSS.0b013e31821ece12
37 Fayyad UM, Piatetsky-Shapiro G, Smyth P. Knowledge Discovery and Data Mining: Towards a Unifying Framework. In KDD, 96, 82-88, 1996.
38 Hall MA. Correlation-based Feature Subset Selection for Machine Learning. New Zealand: Hamilton, 1999.
39 Kira K, Rendell LA. A practical approach to feature selection. In: Proceedings of the ninth international workshop on Machine learning. Morgan Kaufmann Publishers Inc, 1992. https://doi.org/10.1016/b978-1-55860-247-2.50037-1
40 Kononenko I. Estimating attributes: analysis and extensions of RELIEF. In Machine Learning: ECML-94. Springer Berlin Heidelberg, 1994: 171-182. https://doi.org/10.1007/3-540-57868-4_57

41 Robnik-Šikonja M, Kononenko I. An adaptation of Relief for attribute estimation in regression. In Machine Learning: Proceedings of the Fourteenth International Conference (ICML'97), 1997.
42 Quinlan JR. Learning with continuous classes. In: Proceedings of the 5th Australian joint Conference on Artificial Intelligence 1992: 92; 343-34
43 Quinlan JR. C4.5 Programs for Machine Learning. San Mateo: Morgan Kaufmann Publishers, 1993.
44 Wang Y, Witten IH. Inducing model trees for continuous classes. In: Proceedings of the Ninth European Conference on Machine Learning, 1997: 128-113.
45 Agrawal R, Srikant R. Fast algorithms for mining association rules. In: Conference on Very Large Databases, 20, Proccedings … San Francisco, Morgan Kaufmann, Santiago do Chile, 1994.
46 Ma BLWHY. Integrating classification and association rule mining. In: Proceedings of the 4th, 1998.
47 Bassett Jr DR, Wyatt HR, Thompson H, Peters JC, Hill JO. Pedometer-measured physical activity and health behaviors in United States adults. Medicine and science in sports and exercise 2010; 42(10): 1819.
https://doi.org/10.1249/MSS.0b013e3181dc2e54
48 Pardini R, Matsudo S, Araújo T, Matsudo V, Andrade E, Braggion G, Raso V. Validação do questionário internacional de nível de atividade física (IPAQ-versão 6): estudo piloto em adultos jovens brasileiros. Revista Brasileira de Ciência e Movimento 2001; 9(3): 39-44.
49 Benedetti TRB, Antunes PDC, Rodriguez-Añez CR, Mazo GZ, Petroski EL. Reprodutibilidade e validade do Questionário Internacional de Atividade Física (IPAQ) em homens idosos. Revista Brasileira de Medicina do Esporte 2007; 13(1): 11-6. https://doi.org/10.1590/S1517-86922007000100004
50 Tudor-Locke C, Williams JE, Reis JP, Pluto D. Utility of pedometers for assessing physical activity. Sports Medicine 2002; 32(12): 795-808.
https://doi.org/10.2165/00007256-200232120-00004

**Número de citas totales / Total references:** 50 (100%)
**Número de citas propias de la revista / Journal's own references:** 1 (2%)