International Journal of Multidisciplinary and Current Research ISSN: 2321-3124
Research Article Available at: http://ijmcr.com

Comparison of Two Different Methodologies (Subjective & Objective) for Assessment of Physical Activity Level in Tunisian Obese Women

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Received 20 Oct2020, Accepted 26 Dec2020, Available online 02 Jan2021, **Vol.9 (Jan/Feb 2021 issue)**

Abstract

Physical activity and sedentary behaviour are difficult to assess in overweight and obese women. However, the use of open-source, raw accelerometer data analysis could overcome this. This study compared raw accelerometer and questionnaire-assessed moderate-to-vigorous physical activity (MVPA), walking and sedentary behaviour in obese women, and determined the effect of using different methods to categorise obesity. Hence, the objective of this study was to provide information on the situation of obese Tunisian women, describing their physical activity habits using two measurement : the self-report the International Physical Activity Questionnaire-long form (IPAQ) and accelerometry. 54 women with booking BMI≥ 30 kg/m^{2}were consisted in a questionnaire on their food and physical activity habits and anthropometric measurements, and wore an accelerometer (ActiGraph) for seven days afterwards. The IPAQ and the ActiGraph were compared in terms of estimated Metabolic Equivalent Task minutes per week (MET-min/wk), minutes spent in activity of moderate or vigorous intensity (MVPA), and agreement in the classification of physical activity. Accelerometer thresholds of 100 counts/min, 1952 counts/min and 5725 counts/min were used to define light and moderate or vigorous physical activity respectively. 54 obese women (meanage : 42.72 ± 11. 26 years ; mean BMI : 38.82 ± 6.33 kg/m^2) were recruited and completed the study whereas 46 were excluded (Incomplete data). In participants, serum uric acid concentrations correlated positevely with body mass index (r=0.598) and body fat mass (r=0.423), and negatively with high-density lipoprotein cholesterol (r= - 0. 226). IPAQ and acceleromter were not significantly correlated on estimation of total (r=0.138 ; p<0.0001), light(r=0.141 ; p<0.0001), moderate (r=0.173 ; p<0.05) and MVPA (r=0.149= ; p<0.05) Metabolic Equivalent minutes /day (MET min $^{-1}$day^{-1}) showing poor absolute agreement. In comparaison with the actigraph, the IPAQ under predicted daily total METs and over predicted vigourous METs. Relationship between accelerometer and questionnaire-assessed vigourous PA (r= -0.48 ; p=0.496) were stronger whilist sedentary behavor were modest (r= 0.108; p<0.0001). Compared with the accelerometer, the subjective IPAQ measure performed less accurately in estimating of PA in obese women. Future research measuring activity in obese women should optimally encompass objective measures of physical activity.

Keywords *: Actigraph, IPAQ, obesity, uricacid, MVPA, women*

Introduction

Obesity is associated with all-cause mortality [1, 2] and the high prevalence of overweight and obesity continues to pose major public health challenges. In 2014, more than 1.9 billion adults worldwide were overweight and more than 600 million were obese [3]. A number of potential factors have contributed to explain the global high increase in obesity over the past three decades such as increase in calorie intake, change in composition of diet and decline in physical activity.

Concern about co-morbidities associated with increasing obesity has become well recognized. Indeed, being overfat shares direct links to insulin resistance and chronic inflammation, and to hypertension, dyslipidemia, coronary heart disease, stroke, cancer, Type 2 diabetes, gallbladder disease, osteoarthritis and gout, pulmonarydiseases, sleepapnea, and others [4] and the worldwide prevalence of obesity has increased to more than double between 1980 and 2014 [5]. Given the high prevalence of obesity in the world and the numerous associated health risks, information is needed on temporal trends in the prevalence of overweight, obesity, and extreme obesity. Standard behavioural weight loss

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DOI : https://doi.org/10.14741/ijmcr/v.9.1.1

interventions typically recommend increasing physical activity and decreasing energy intake to promote weight loss [6, 7]. Physical inactivity is considered a major contributor to the development and progression of overweight and obesity. A possible explanation for the association between obesity and physical inactivity is that excess weight has a negative impact on the biomechanical characteristics of the lower extremities [8]. Objective and subjective methods, such as accelerometers and questionnaires, are currently the most commonly used methods to measure physical activity. Self reported data are subject to recall and reporting biases, and poor agreement between objective and subjective measures of physical activity has been reported [9, 10]. In developing countries, like Tunisia, a high proportion of people are facing some new problems as hypertension, obesity, diabetes and tobacco smoking [11]. Few studies in Tunisia have investigated the implication of socio-economic status in the prevalence of obesity. In the Middle East and North Africa (MENA) where obesity, especially among women, is now a major public health challenge [12, 13]. Tunisia is typical of countries in the MENA region that have undergone a rapid epidemiological and nutrition transition, and today features a high prevalence of obesity and type 2 diabetes, with close to one-third of Tunisian adults reported to be affected by the metabolic syndrome [14, 15]. Although, a large number of studies have reported associations between obesity and physical activity behaviours using questionnaires in Tunisia, little research has been conducted about the relationship of obesity risk with objectively measured physical activity.

Therefore the current study compares self-reported physical activity using the questionnaire method with objectively recorded physical activity using accelerometry in obese Tunisian women.

Material and Methods

Participants

To be included in the present study, the participants had to accumulate the following criteria: be obese (BMI ≥30 kg/m^2) without cardiovascular complications, have not engaged in regular physical exercise (*e.g.*, walking/running, strength training, etc.) for at least 6 months prior to the study; have signed the written informed consent form for study participation.

We performed a power analysis for physical activity in this study, based on the International Physical Activity Questioner (IPAQ) and the use of accelerometer.

A total of 100 women were evaluated, but only 54 met the study inclusion criteria. After assessing the physical activity levels of the participants using accelerometry, we found that 46 of them had not used the device for the prescribed minimum number of days (4 days during the week and 1 day during the weekend). Thus, the final sample selected for the analysis comprised 54 women.

All procedures used in this study met the criteria of the Resolution on Ethics in Research of the National Health Council. The protocol of the survey was reviewed and approved by the Ethics Committee on Human Research of the National Institute of Nutrition and Food Technology, and the Tunisian National Council of Statistics. After being thoroughly informed on purpose, requirement, and procedures, all participants included in the survey gave their free informed consent.

Data collection

Anthropometry, blood pressure and body composition

During anthropometric measurement, all participants wore light clothing and remained barefoot. Body weight was precised using a digital electronic scale (Seca, Hamburg, Germany, 896 (150±0.1kg). The height of the subjects was measured to the nearest 0.1 cm using a mobile vertical anthropometer (Alturexata®). Body mass index (BMI) was calculated as weight in kilogram divided by the square of height in meter (Kg/m^2). All the measures were performed twice. Waist circumference was measured with a standard tape measure, with the base of the tape placed at the top of the umbilicus (to the nearest 0.5 cm). Resting blood pressure was measured using an Omron M10-It monitor (to the nearest mmHg) (Omron, Milton Keynes, UK) following 5 min of seated rest.

Body fat was analyzed with impedencemetry (Tanita BC-418MA). Each examination lasted for approximately 15 minutes. The values were expressed as a percentage of body fat (%BF), free fat mass (%FFM) and the total body water (%TBW).

Assays

The fasting blood levels of glucose, uric acid and lipids were measured in the clinical biochemistry laboratory of the national institute of nutrition. After serum separation, some blood biochemical factors including: fasting blood glucose (FBS), triglyceride (TG), total cholesterol (TC), high-density lipoprotein-cholesterol (HDL-C), uric acid (UA) were evaluated. The TC, TG, UA and HDL-C in plasma were determined using a timed endpoint enzymatic method with The SYNCHRON LX® System, UniCel® DxC 600/800 System. Glucose concentration was measured by an oxygen rate method employing a Beckman Coulter Oxygen electrode. The low density lipoprotein-cholesterol was calculated by the formula of Friedewald et al, [16].

Physical activity evaluation

- IPAQ and Sedentary Time

Self-reported total moderate-to-vigorous PA and ST were assessed using the self-administered version of the International Physical Activity Questionnaire (IPAQ)-long form [9]. The IPAQ-long form is a questionnaire used to estimate the time spent in PA and ST in adults aged between 18–65 years over a seven-day period and has been validated in over 12 countries [17]. The IPAQ summarized behavior that occurred the previous week. IPAQ questions pertain to the number of days and average time spent on a given day doing MVPA in five domains: work, transportation, garden or yard, home, and leisure time and, is therefore preferred over the IPAQ-short form for research purposes [9]. Respondents report activities that last at least 10 consecutive minutes. Self-reported duration (in minutes) and frequency (in days) across all five domains were then computed to produce an output for PA and ST. Based on the IPAQ protocol, the minutes per week (min/week) that were generated for PA were then multiplied by a metabolic equivalent of task (MET). METs are assigned to different forms of activity based on the level of intensity (walking = 3.0, moderate = 4.0, and vigorous = 8.0), to give a final output for PA and ST in MET–min/week.

- Accelerometer

The habitual levels of physical activity of the participants were assessed using a triaxial accelerometer sensor (Actigraph model GT3X, United States), which recorded the movements in the three orthogonal planes: vertical, horizontal anteroposterior, and horizontal mediolateral. To carry out the measurements, the accelerometers were attached to an elastic tape and placed on the subjects' waist, above the hip, at the height of the iliac crest on the right side of the body. Prior to the first visit; the accelerometer was initialized and set to record physical activity in 60-second epoch [18-19]. The participants were required to use the accelerometer for 7 days, and were asked to remove the accelerometer any time they were to perform activities that involve the use of water such as bathing or swimming, and when going to bed. On the 8th day, the participants were visited for the second time to collect the accelerometer.

Specific software (ActiLife 5, data analysis software by Actigraph) was used to process the obtained data, and only results obtained during full monitoring days were analyzed. A non-wear time was defined as at least 60 consecutive minutes with zero counts, with an allowance of up to 2 minutes of counts between [20]. A valid day was defined as ≥ 10 hours of monitor wear time, and only participants with ≥ 4 valid days (including at least 1 day during the weekend) were integrated in the present analyses [20].

Raw measurements from the accelerometer were determined as *counts*, which was an arbitrary measurement: the greater the number of counts, the higher the level of physical activity. Countsfrom each sample were added over a specific period of 60 seconds called an epoch. The period of 60 seconds was chosen for this study population due to the type of physical activity, which is characterized by a low intensity and long duration pattern. The Freedson et al. [21] cut-off points was used to determine the time spent in various levels of PA (0–99 counts/min = sedentary, 100–1951 counts/min = light intensity activity, 1952–5724 counts/min = moderate intensity activity, 5725–9498 counts/min = vigorous intensity activity, and >9499 = very vigorous intensity activity). These cut-off points have previously been used in South Asian populations and therefore, were deemed appropriate for this study and allowed for comparability with the published data [22-23].

Statistics

All data collected was analysed using SPSS Data Analysis version 19.0 (SPSS Inc, Chicago, IL). Wilcoxon signed-rank tests were used to compare median differences between methods used. Spearman correlation was used to assess the relationship between estimates of activity measured, including daily step count and daily total, light, moderate and vigorous MET min^{-1}. Bland-Altman analysis was used to assess the agreement between the MET min^{-1} day^{-1} estimated by the accelerometer-IPAQ in assessing physical activity. Bland-Altman analysis uses mean differences between devices and does not assume normality [24-25]. A power analysis was performed to determine the minimal sample size required in order to detect a correlation coefficient of 0.5 between two measures. In order to achieve at least 80% power with a significance level of a = 0.05, a sample size of n = 54 was required.

Results

1. Demographic Characteristics

Demographic characteristics of the subjects are presented in Table 1. The mean age, BMI waist circumference, MET B, of participants were 42.72±11.26 years, 38.82±6.33kg/m^2, 116.8 ± 14.54 cm, 1721.3±218.09 kcal, respectively. The mean serum uric acid concentration (295.43±66.9 µmol/L) was high but in the normal range (<357 µmol/dL), and 27.77% of the women exceeded this normal range. Uric acid was positively correlated with BMI (r=0.59), body fat mass (r=0.423) and triglyceride (r=0.425) while the overall Spearman correlation between waist circumference and uric acid was low (r=0.29) (Table 2).

Table 1 : Subject Characteristics

N	54
Age (years)	42.72 ± 11.26
BMI (kg/m^2)	38.82 ± 6.33
Waist circumference (cm)	116.8 ± 14.54
Systolic blood pressure (mm Hg)	126.5 ± 1.15

Dyastolic blood pressure (mm Hg)	78 ± 0.82
Fasting plasma glucose (mg/dl)	5.34 ± 1.22
TG (mg/dl)	1.46 ± 0.45
HDL-C (mg/dl)	0.9 ± 1.78
LDL-C (mg/dl)	3.04 ± 0.85
TC (mg/dl)	5.01 ± 1.22
SUA (µmol/l)	295,42±66,89
Energy intake (kcal)	1721.3±218.09
Percentage of FFM (%)	54.39±6.37
Percentage of BF (%)	45.14±12.05
Percentage of TBW (%)	40.4±6.41

Values are means ± standard deviation. BMI, body mass index; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol; TG, triglyceride, SAU, Serum uric acid ; FFM, Free fat mass ; BF, Body Fat ; TBW, Total body water were determined in 54 subjects.

Table 2 : Spearman' rank correlations coefficient between serum uric acid, and anthropometric indices, body composition and lipid profil

Serum uric Acid	Variable	Spearman correlation coefficients
SUA	BMI	r=0.598
SUA	WC	r=0.296
SUA	BF	r=0.423
SUA	TC	r=0.199
SUA	TG	r=0.425
SUA	HDL-C	r= - 0.226
SUA	LDL-C	r=0.143

BMI, body mass index; WC, Waist circumference, HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol; TG, triglyceride ; SAU, Serum uric acid ; BF, Body Fat.

2. IPAQ and accelerometer

The overall Spearman correlation between the IPAQ and ActiGraph waslow (r=0.034) for estimating sedentarity, and was modest on estimation of total (r=0.138) ; light (r=0.145), moderate (r=0.173) and MVPA (r=0.149) MET $min^{-1}day^{-1}$ (Table 4). Accelerometer and questionnaire-assessed measures were significantly different in participants regarding meandaily total Met min^{-1} (p<0.0001), sedentarity (p<0.0001), light (p<0.0001), moderate (p<0.05) and MVPA (p<0.05) whereas vigourous activity did not reach statistical significance (Table 3).

Table 3 : Daily estimates at different intensities of physical activity and sedentary behaviors according to subjective methodology, questionnaire (IPAQ), and objective methodology, accelerometer (the actigraph) in tunisian obese women.

Variable	IPAQ	Accelerometer	p
Total steps (counts/day)	-	10214.66 ± 3983.32	-
Sedentarity (MET–min/week)	4744.44±1329.73	3478.67±1392.24	p<0.0001 ***
Light PA (MET–min/week	1276±741.84	2982.35±2248.06	p<0.0001 ***
Moderate PA (MET–min/week	386.67±224.8	302.54±202.8	p= 0.029 *
Vigourous PA (MET–min/week	7.41±38.9	3.56±11.94	p=0,496
QMVPA (MET–min/week	394.07±224.31	306.11±205.79	p=0.025 *
Total Met min^{-1} $week^{-1}$ (MET min^{-1}/week)	1351.69 ± 422.7	684.43±244.24	p<0.0001 ***

Values are means ±standard error. PA : physical activity. p<0.05 for difference between instruments used (IPAQ vs Actigraph), based on Wilcoxon signedranks test. * : significantly different from accelerometer Met min^{-1} estimates (p<0.05), (** p<0.01) and (*** p<0.001)

Table 4 : Spearman' rank correlations coefficient for total physical activity and time spent in physical activity and sedentarity from IPAQ and actigraph

IPAQ	Actigraph	Spearman correlation coefficients
Vigourous	Vigourous	r = - 0.48
Moderate	Moderate	r = 0.173
Light	Light	r = 0.141
MVPA	MVPA	r = 0.149
Total PA	Total counts	r = 0.138
Time spent in sitting	Sedentarity	r = 0.034

Cut-off values for sitting, light, moderate, and vigourous were<99, 100-1951, 1952-5724, and >5725, respectively.

IPAQ total PA (MET min d^{-1}) ; Actigraph total count (count min^{-1})

3. Bland and Altman plots (Figure 1)

Figure A shows Bland-Altman plots of the sedentary time data. For each calculation, the boundaries of the confidence interval for the mean of the 2 methods were on the same side of y=0, indicating statistically significant differences between the actigraph and the IPAQ 1265.77±1892.51 minutes per day. The limits of agreement were -2443.54 to 4975,08min/day. The mean difference between the two methods for estimating time spent in light PA was -1706.35±2265.54min/day and the limits of agreement were -6146.80 to 2734.10min/day (Fig B) indicating that IPAQ systematically underestimates the time spent in light PA compared to the accelerometer. Figure C shows Bland-Altman plots of the difference between an accelerometer (Actigraph) and the IPAQ for measuring daily time spent in moderate physical activity in women with obesity. The thick line indicates the mean difference (84.13±275.47min/day) between the 2 tests indicating that IPAQ systematically overestimates the time spent in moderate PA compared to the accelerometer. The thin lines indicate the limits of agreement (1.96 × the standard deviation of the mean difference) and were -455.79 to 624.05 min/day (Fig C). The Bland-Altman plot for total physical activity MET-$min.d^{-1}$ from the IPAQ and the accelerometer ($count.min^{-1}$) showed a mean difference of 667.25 (458.03) MET-$min.d^{-1}$, and the 95% limits of agreement werewide (-230.50 to 1565 MET$min.d^{-1}$) (Fig E). For time

spent in vigourous physical activity, the mean difference was 3,85± 41,24 min.d^{-1} and the 95% limits of agreement were (-76.98 to 84.68 min.d^{-1}) (Fig D). The mean error scores for min.day^{-1}reported in Moderate-to-Vigorous (MVPA) physical activity from the Actigraph and IPAQ (87.96±280.86 min.day^{-1}) are illustrated by a solid horizontal line and the limits of agreement (±1.96 SD from the mean) are shown as thin horizontal lines (-462.52 to 638.44 min.day^{-1}) (Fig F).

Discussion

Obesity is now well recognized as a disease in its own right, one that is largely preventable through changes in lifestyle, especially diet. In Europe, overweight and obesity affect 30–80% of the adult population [26]. In the inter-country comparable overweight and obesity estimates from 2008, more than 50% of adults were overweight in 46 out of the 51 countries, and more than 20% were obese in 40 countries [27]. Serum uric acid level, an end product which is produced by endogenous metabolism and exogenous urine in human beings [28], was strongly linked to vary kinds of metabolic syndrome [29-30]. An independent risk factor for female abdominal obesity and metabolic syndrome is the elevated level of serum uric acid [31]. Higher serum concentrations of uric acid because of both increased production and decreased excretion probably account for the progressive increase in risk associated with adiposity [32-33].

Our results show that serum uric acid was positively correlated with BMI (r=0.59), body fat mass (r=0.423) and triglyceride (r=0.425), and 27.77% of participants exceeded the normal range (<357 µmol/dL). Uric acid is the metabolic end product of the purine nucleotides that are components of cellular energy molecules, such as ATP, and of DNA and RNA. Hyperuricemia increases the risk of gout through the formation of urate crystals. However, hyperuricemia is not just important in gout but it is also an independent risk factor for hypertension, atherosclerosis, insulin resistance and type 2 diabetes [34-35]. Although obesity is associated with hyperuricemia [36-37], the precise role of hyperuricemia in obesity is not clear. It could be due to an increased uric acid production coupled with triglyceride synthesis [38-39] and decreased uric acid excretion into urine as a result of hyperinsulinemia or insulinresistance, which accompany obesity [40-41]. Unlike the deleterious influence of hyperuricemia on the development of gout and lifestyle-related disease, uric acid is considered to be a powerful antioxidant [42-43]. Therefore, researchers have suggested that hyperuricemia might be a compensatory response to counteract excessive oxidative stress [42]. Since obesity is associated with increased oxidative stress [44], hyperuricemia may represent a response to this increased oxidative stress.

Technological advances in the objective monitoring of physical activity now make it possible to obtain measures of sedentary behaviour, physical activity intensity and physical activity type from a single, body-worn accelerometer. The purpose of this study was to assess the performance of simple subjective (IPAQ) physical activity and sedentary time measurement tools against the comprehensive objective accelerometer in obese Tunisian women. The results of the current study show that relative to the accelerometer provided better estimates of physical activity in obese women than the IPAQ, which showed poor absolute agreement and systematic error. The IPAQ showed no relationship (r = 0.138 ; p<0.0001) and poor agreement with the accelerometer for estimating daily total physical activity, calculated in MET min^{-1}, which persisted even when MET min^{-1} were further categorised in to light (r=0.141 ; p<0.0001) and moderate (r=0.173, p = 0.029) activity indices. Additionally, no relationship was observed between accelerometer and IPAQ estimated MVPA and ST (r = 0.149 (p<0.05) ; r=0.034 (p<0.0001), respectively). Consistent with our findings, other studies reporting relationships between subjective and objective measures have also shown weaker relationships in comparison to relationships between objective measures [45-46]. These results suggest that the IPAQ may not accurately measure PA/ST in the obese tunisian women. In fact, our results indicate that IPAQ significantly underestimated sitting and overestimated time spent in vigourous PA. Group associations across measures revealed significant differences in total PA, light, moderate, sitting and MVPA for the whole group.The IPAQ was chosen in this study as the questionnaire attempts to estimate light, moderate and vigorous physical activity across a number of different domains. However, despite the added domains in the IPAQ, our results suggest it still is insensitive in capturing physical activity in obese women. Alternatively, the added domains within IPAQ may increase inaccuracy in self-reporting with participants required to interpret and separate activity in to specific domains. These considerations highlight the need for an effective, yet simple validated self-recalled measure that accurately captures physical activity levels during this time.

A deepening of the confrontation between of the two methods was performed using analysis Bland and Altman. As showen in figure 1 (fig A, B, C, E and F), the Bland and Altman plots showed low levels of agreement between the two tools (IPAQ and accelerometer) for estimating time spent in different time physical activity in obese tunisian women. The dispersion of the differences was wide, indicating less agreement. The greater the amount of time spent on MVPA, sedentarity, light, total, moderate physical activity, the larger the difference between methods. For time spent in vigourous physical activity, the mean difference was 3.85± 41.24 min.d^{-1} and the 95% limits of agreement were with in reasonable range (-76.98 to 84.68 min.d^{-1}). Differences (i.e., error) between the IPAQ and accelerometer scores slightly increased as the minutes per day in vigourous reported on the IPAQ increased (Fig D). Horizontal lines are plotted at the line of equality (0), representing no difference

between methods, and at the limits which include 95% of the observed data (Fig D).

Correlations between accelerometer and questionnaire-assessed physical activity were equivalent to the highest reported in similar studies using traditional devices [47]. A key recommendation regarding the objective monitoring of physical activity is that data should be collected and saved as raw acceleration signals to allow the storage of large amounts of movement data [48] and facilitate future comparisons of data across studies regardless of which accelerometer is used [49]. However, current recommendations make no reference to the analysis of raw accelerometer data in overweight and obese populations.

Due to the wealth of evidence associating MVPA with the greatest health benefits, most epidemiological studies assess physical activity expressed in MVPA (mins/day) [50]. Similarly, instead of using the IPAQ derived MET values to calculate MVPA [10], self-reported mins/day of moderate and vigorous physical activities were used for analysis. We found weaker associations between accelerometer and questionnaire-assessed MVPA ($r=0.149$, $p<0.05$). The same results were previously reported in the literature. Accelerometer and questionnaire-assessed MVPA from the Whitehall II Study showed modest correlations ($r= 0.33$) [51]. In obese peaple, authors used wrist-worn accelerometers, which are less burdensome to the participant, but provide a poorer measure of total body movement [52-53]. Furthermore, care should be taken when monitoring MVPA in overweight and obese populations using accelerometers validated in non-obese adults. Since moderate (< 3–5.99 METs) and vigorous (> 6 METs) physical activity is based on MET cut-points derived from VO2 where 1MET = 3.5 mL/kg/min− 1, MVPA will be altered in overweight or obese populations since obesity is associated with reduced cardiorespiratory fitness [54] and diminished metabolic capacity [55]. Since, accelerometer detect vigorous activity more accurately than lighter activity [56], stronger associations between questionnaire and accelerometer-assessed vigourous were found in obese women than previously reported.

Collectively, these findings go some way in explaining why sedentary behaviouris an independent risk factor for weight gain [57], meaning research investigating sedentary behaviour in overweight and obese individualsis of increasing importance. Therefore, sedentary behaviours hould be explicitly quantified in research and not simply defined by a lack of physical activity [58]. Objective measurement methods such as pedometers [59] and some accelerometers [60] are deemed unsuitable for overweight and obese populations and likely contribute to the weak associations with questionnaire-assessed walking reported in previous studies [61-62]. We found weaker associations between accelerometer and questionnaire-assessed sitting in obese women. Likewise, many other studies have reported the same results in the literature. Obese participants were less active than their leaner counterparts. Therefore the low concordance between accelerometer and questionnaire-assessed sitting is probably due to the non use of activity classification techniques.

Results of the present study indicatethat the IPAQ may not accurately measure PA/ST in women with obesity and therewere no significant correlations between accelerometer derived PA/ST and IPAQ derived PA/ST. In fact, the correlation between accelerometer and IPAQ derived PA was lower, indicating that those with higher objectively measured PA tended to report lower PA levels within the IPAQ. In both the measurement of PA and ST, the IPAQ underestimated the level of activity of participants when compared to accelerometer, derived data.

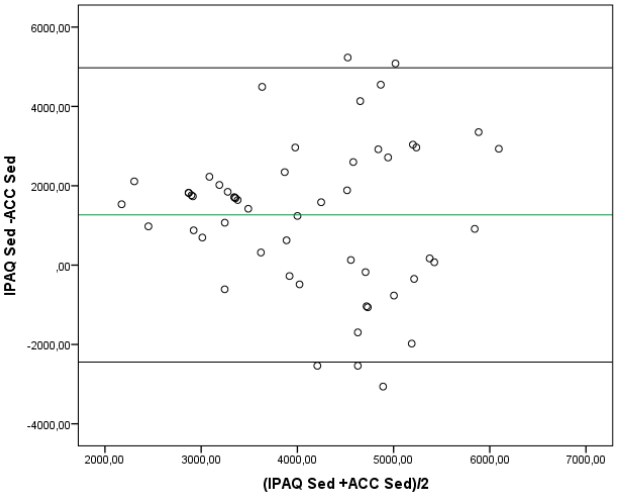

Figure A : Bland and Altman plots with differences in mean spent time in sedentarity behaviour between IPAQ and actigraph (min/day).

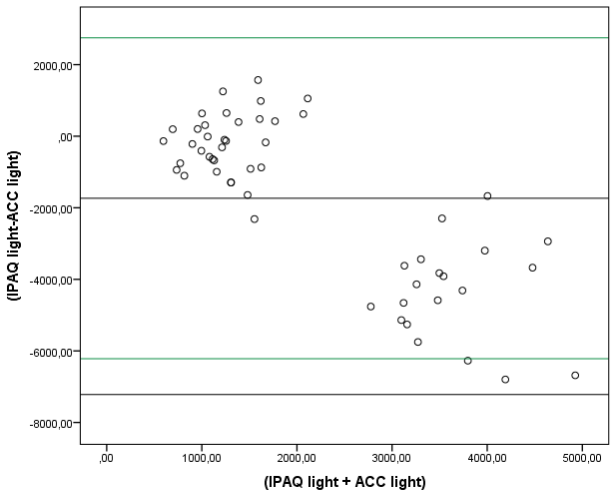

Figure B : Bland and Altman plots with differences in mean spent time in light PA between IPAQ and actigraph (min/day).

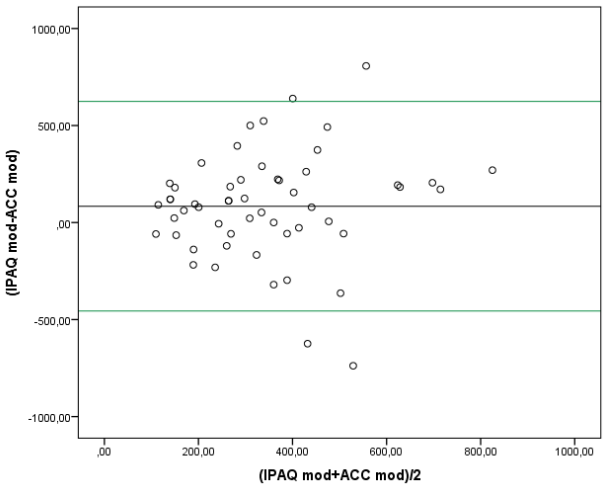

Figure C : Bland and Altman plots with differences in mean spent time in moderate PA between IPAQ and actigraph (min/day).

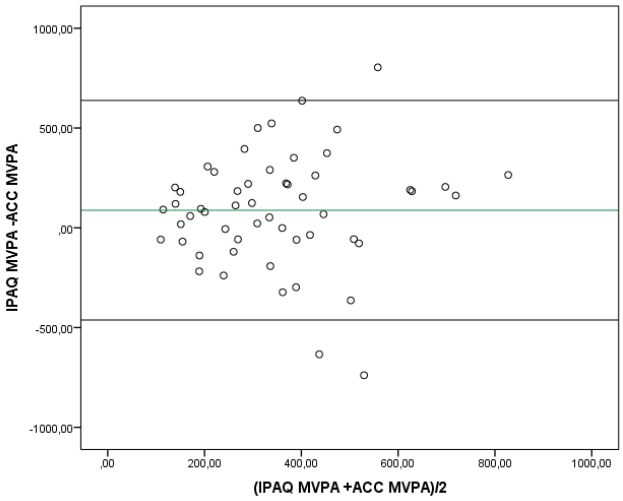

Figure F : Bland and Altman plots for min day^{-1} reported in Moderate to Vigourous PA (MVPA) from Actigraph and IPAQ.

Conclusion

In summary, Serum uric acid may be associated with obesity. However, and further study should be established to explore deep relationship between serum uric acid and obesity by adding in more obesity related factors. The PA measurement in obese women, has demonstrated that in comparison to the subjective IPAQ, has high relative and absolute disagreement with the the objective comprehensive accelerometer tool. Accelerometers provide valid and reliable data interpretable in terms of public health. IPAQ is the most common method to monitor PA, but it needs to be adapted for use in obese peaple. The study suggests that further research on other subjective measures of physical activity is warranted in obese women. In addition, we propose that further research in corporating objective measures of PA is important to inform clinicians, community and policymakers on optimal PA recommendations in obese women.

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