

Calibration of MTI actigraph in old obese adult

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Abstract

Purpose: to derive a regression equation that estimates energy expenditure from accelerometer counts in old obese adult.

Methods: The sample comprised 14 old obese or overweight adults (63 ± 7 years). VO_2 was measured using a stationary breath-by-breath metabolic unit. Each participant wore two MTI Actigraphs over right hip, to prevent any malfunction, or other hazard occurrence, which were the same for all participants. The variation between the unities was low ($R=0.99$). Only the data of the same unity was used. 1 min. epoch was used. Each participant did these activities in sequence: rest, seated, stand, walk at $2.5\text{km}\cdot\text{h}^{-1}$, walk/run at $5\text{km}\cdot\text{h}^{-1}$, and run at $7.5\text{km}\cdot\text{h}^{-1}$, and VO_2 and counts were simultaneously assessed. Rest VO_2 was collected for 15 min with the participants in a lay position. For all activities other than rest, VO_2 and counts were collected during 6 min., with the mean value of the last 3 – 6 min. used for data analysis. A hierarchical linear model was used to analyze the relationship between accelerometer counts and VO_2 .

Results: Coefficients associated with quadratic and cubic trends in third polynomial model were not found to be significantly different from zero. The contribution of body mass index, waist-to-hip ration, sum of skinfolds and gender were not found to contribute significantly to the fit of the model. Thus only results from the unadjusted linear mixed model are reported here. The association between counts and energy expenditure was 0.85. The derived equation was:
 $\text{Kcal}\cdot\text{Kg}^{-1}\cdot\text{min}^{-1} = 0.01759869364314 + 0.00001693987728616 (\text{counts}\cdot\text{min}^{-1})$

Introduction

One of the most important physical activity dimensions is energy expenditure, since the improvement of energy expenditure could cause a negative energetic imbalance. It is important to assess the energy expenditure of the obese individuals that are engaged in physical activities programs, mainly because it is important to control the exercise intensity and to have an indicator of total energy expenditure.



There are several ways to assess physical activity energy expenditure, but one that could be used in the field, because of low cost and ease of use, is by means of accelerometers. Accelerometers should be calibrated to have population specific energy expenditure equations (Freedson, Pober and Janz, 2005; Welk, 2005). Although, the calibrated study done (Freedson, Melanson and Sirard, 1998; Hendelman *et al.*, 2000; Yngve *et al.*, 2003) were with young and healthy adults.

Purpose

The purpose of this study was to develop a regression equation to estimate energy expenditure with MTI actigraph accelerometer counts in old obese adults.

Sample

All subjects were recruited from a physical activity program “*Mexa-se em Bragança*” (move in Bragança) designed to secondary prevention and as a treatment complement of type 2 diabetes. All participants are older adults and most of them suffer from type 2 diabetes and are obese.

Sample for energy expenditure prediction equation (Sample 1)

Sample 1 comprised 14 old adults, 7 male and 7 female, with ages between 53 and 71 years (mean=63±7 years). BMI were 28.4±2.1 and 33.1±6.2 respectively for male and female subjects.

Sample for validation of prediction model (Sample 2)

Sample 2) comprised 12 old adults, 4 male and 8 female, with ages between 47 and 68 years (mean 62.2±6 years). BMI for males is 28.5±4.9 and for females is 29.7±5.4.

Instrumentation

Oxygen consumption ($\dot{V}O_2$) and heart rate were measured using a stationary breath-by-breath metabolic unit (Cortex, Model MetaLyzer 3B, Leipzig, Germany).

Each participant wore two MTI Actigraphs model 7164 (Manufacturing Technologies, Inc., Health Systems, FL, USA) over right hip, to prevent any malfunction of physical activity monitor, or other hazard occurrence, which were the same for all participants. The two MTI Actigraphs were previously calibrated according to manufacturer parameters. The variation between the unities was analyzed by means of intraclass correlation, the value was high ($R=0.99$). Only the data of the same unity in all subjects was used to the subsequent analyze. Activity counts were stored in 1 min. time interval.



Study design

It was asked to all participants to come 3 hours after the last meal. To evaluate $\dot{V}O_2$ and accelerometry counts simultaneous, each participant did the following physical activities in sequence: rest, seated, stand, walk at $2.5 \text{ km}\cdot\text{h}^{-1}$, walk / run at $5 \text{ km}\cdot\text{h}^{-1}$, and run at $7.5 \text{ km}\cdot\text{h}^{-1}$. These activities were intended to cover the following intensities of physical activity: rest, light, moderate, and vigorous.

Rest $\dot{V}O_2$ was collected for 15 min, with the participants in a lay position, with the room quite and dimly lighted.

Participants were not allowed to sleep. Minutes 6 – 15 were used for data analysis.

For all activities other than rest, $\dot{V}O_2$ heart rate and accelerometer counts were collected during 6 min., with the mean value of the last 3 min. used for data analysis.

Statistical analysis

A hierarchical linear model was used to analyze the relationship between accelerometer counts and energy expenditure ($\text{Kcal}\cdot\text{Kg}^{-1}\cdot\text{min}^{-1}$) over the walk/run activity intensities.

The model can be written as:

$$y_{ij} = \alpha + \beta x_{ij} + a_i + b_i x_{ij} + e_{ij}$$

where y_{ij} denote the response for j th observation on i th participant and α and β are fixed effects that denote the population average intercept and slope, and a_i and b_i represent each participant's random intercept and slope deviations about the corresponding population parameters.

Analysis for inner validation

The bias, which is the difference between the predicted and the corresponding actual value of energy expenditure, and the 95% limits of absolute agreement were calculated as described in (Atkinson e Nevill, 1998). The concordance correlation coefficient ρ_C (Lin, 2000; Mitchell, Baker e Jacklin, 1989) was computed between the predicted and the actual values



Results

$\dot{V}O_2$, counts, and energy expenditure for each physical activity intensity for sample 1

Activity	$\dot{V}O_2$	Accelerometer	Energy
	($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$)	Counts $\cdot\text{min}^{-1}$	expenditure ($\text{Kcal Kg}^{-1}\cdot\text{min}^{-1}$)
	Mean \pm SD	Mean \pm SD	Mean \pm SD
Seat	3.4 \pm 1.7	3.5 \pm 7.6	0.0162 \pm 0.008
Stand	3.7 \pm 1.1	47.2 \pm 47.9	0.0164 \pm 0.007
Walk at 2.5 Km \cdot h $^{-1}$	9.2 \pm 1.9	921.0 \pm 363.4	0.0427 \pm 0.008
Walk/run at 5 Km/h	15.6 \pm 2.7	3835.1 \pm 818.4	0.0732 \pm 0.011
Run at 7.5 Km \cdot h $^{-1}$	23.9 \pm 5.3	5389.5 \pm 1139.1	0.0908 \pm 0.053

$\dot{V}O_2$, counts, and energy expenditure for each physical activity intensity for sample 2

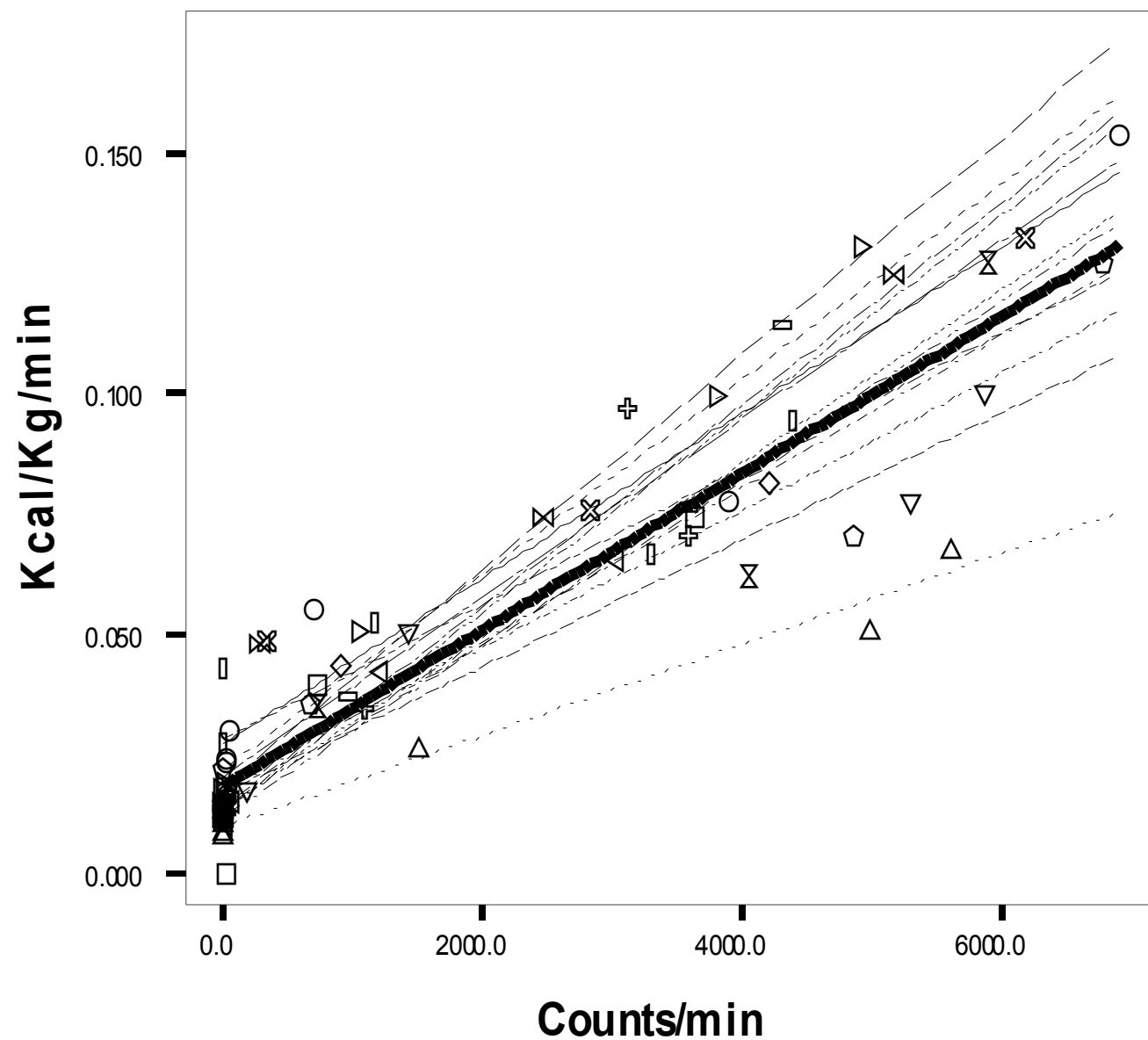
Activity	VO2	Accelerometer	Energy
	($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$)	Counts $\cdot\text{min}^{-1}$	expenditure ($\text{Kcal Kg}^{-1}\cdot\text{min}^{-1}$)
	Mean \pm SD	Mean \pm SD	Mean \pm SD
Seat	3.0 \pm 0.55	2.3 \pm 4.1	0.014 \pm 0.003
Stand	5.7 \pm 3.4	7.5 \pm 14	0.023 \pm 0.012
Walk at 2.5 Km \cdot h $^{-1}$	11.3 \pm 3.9	1035.3 \pm 553.59	0.048 \pm 0.019
Walk/run at Km \cdot h $^{-1}$	17.3 \pm 4.1	3895.2 \pm 1527.9	0.078 \pm 0.021
Run at 7.5 Km \cdot h $^{-1}$	18.7 \pm 6.1	5246.3 \pm 1158.5	0.097 \pm 0.018



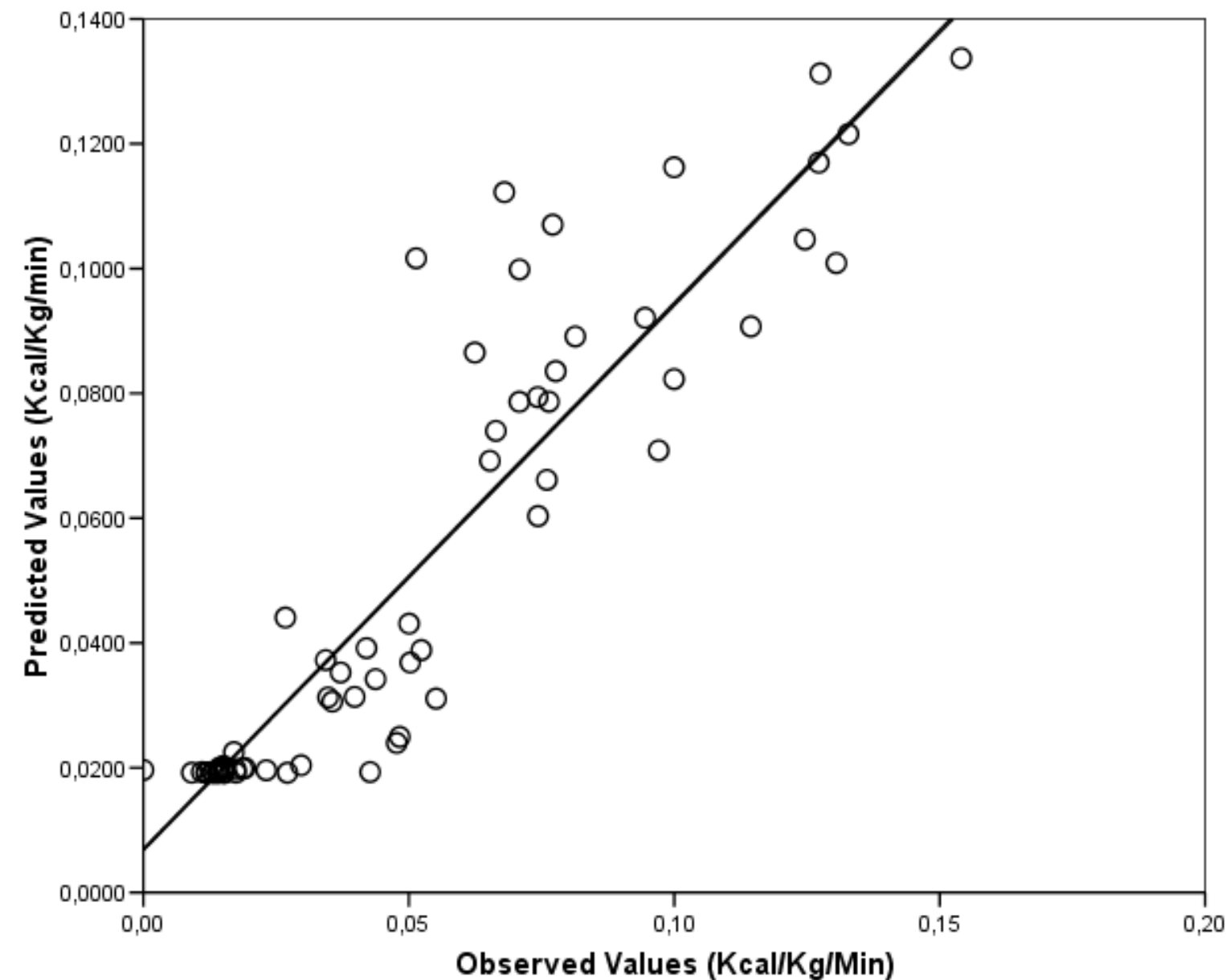
Prediction equation for energy expenditure from counts

$$\text{Kcal}\cdot\text{Kg}^{-1}\cdot\text{min}^{-1} = 0.01759869364314 + 0.00001693987728616 (\text{counts}\cdot\text{min}^{-1})$$

Regression line for energy expenditure versus accelerometer counts (random regression line for each individual and overall regression line)



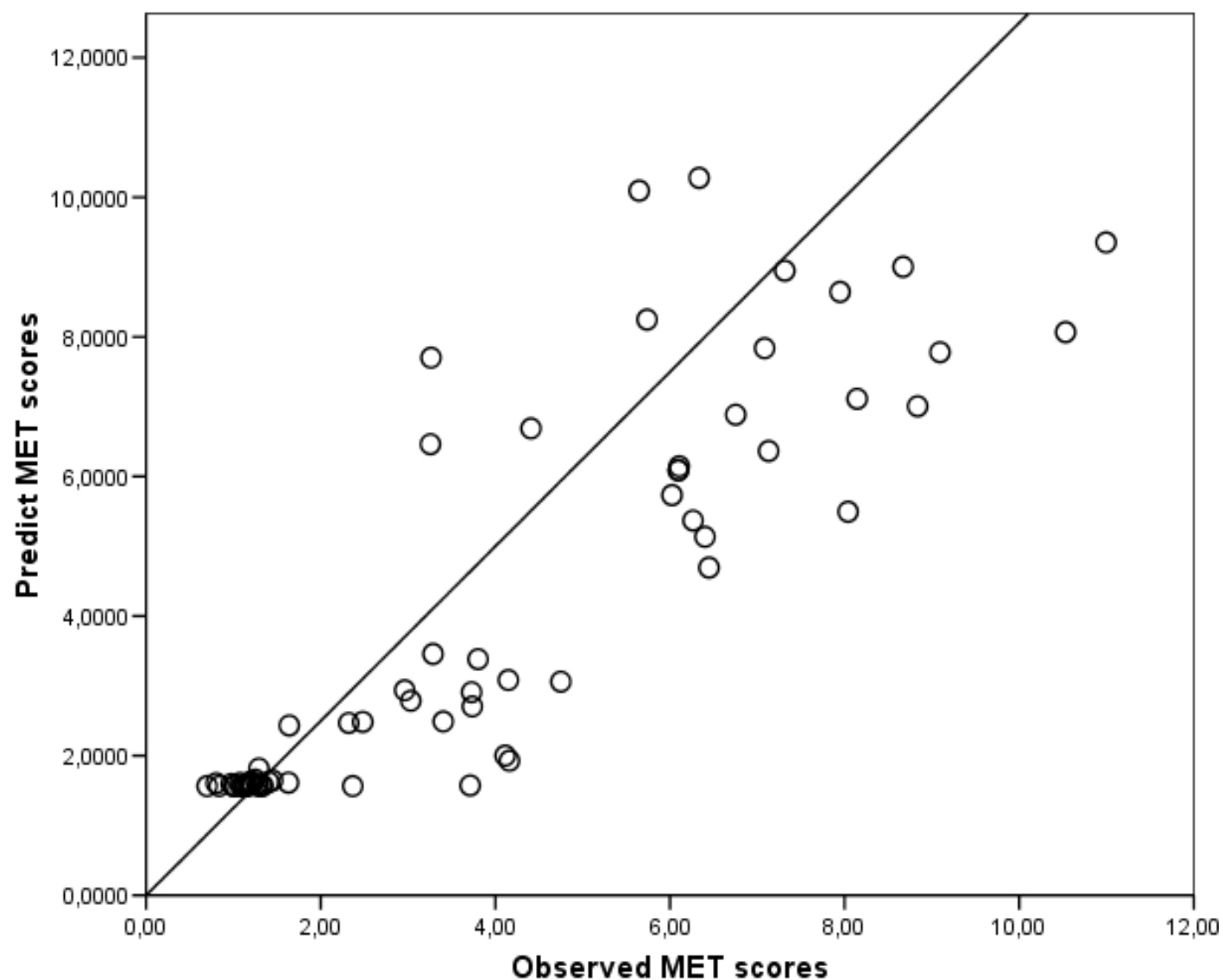
Scatter plot of the estimated energy expenditure ($\text{Kcal}\cdot\text{Kg}^{-1}\cdot\text{min}^{-1}$) regressed versus observed energy expenditure ($r^2 = 0.857$)



Analysis for inner validation

The regression equation derived in sample 1 for prediction energy expenditure ($\text{Kcal}\cdot\text{Kg}^{-1}\cdot\text{min}^{-1}$) was used to estimate energy expenditure in sample 2. The predict energy expenditure correlated with measured energy expenditure ($r = 0.841, p < 0.001$)

Scatter plot of the estimated energy expenditure ($\text{Kcal}\cdot\text{Kg}^{-1}\cdot\text{min}^{-1}$) regressed versus observed energy expenditure ($r^2 = 0.707$)



Summary of the bias of the energy expenditure ($\text{Kcal}\cdot\text{Kg}^{-1}\cdot\text{min}^{-1}$) estimates and their random variation for the two samples

Sample	Mean	Std. Deviation	95% limits of agreement	
1	-0.0004321	0.0142384	-0.02834	0.027475
2	0.0015874	0.020654543	-0.03889548	0.042070328

Conclusion

- Our data show that the MTI actigraph counts were highly correlated with energy expenditure, counts accounted for 85.7% of variation in observed energy expenditure.
- In conclusion:
 - The validation of the CSA against energy expenditure and their calibration for sedentary, light, moderate, and vigorous thresholds certify these monitors as valid, useful devices for the assessment of physical activity in old adults with obesity.

