

Original

# Resting energy expenditure in white and non-white severely obese women

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Abstract

This study aimed to compare the resting energy expenditure (REE) of white and non-white severely obese Brazilian women. REE was examined in 83 severely obese Brazilian women (n = 58 white and 25 non-white) with mean (± SD) age 42.99 ± 11.35 and body mass index 46.88 ± 6.22 kg/m<sup>2</sup> who were candidates for gastric bypass surgery. Body composition was assessed by air displacement plethysmography (ADP) BOD POD<sup>®</sup> body composition system (Life Measurement Instruments, Concord, CA) and REE was measured, under established protocol, with an open-circuit calorimeter (Deltatrac II MBM-200, Datex-Ohmeda, Madison, WI, USA). There was no significant difference between the REE of white and non-white severely obese women (1,953 ± 273 and 1,906 ± 271 kcal/d, respectively; p = 0.48). However, when adjusted for fat free mass (MLG), REE was significantly higher in non-white severely obese women (difference between groups of 158.4 kcal, p < 0.01). REE in white women was positively and significantly correlated to C-reactive protein (PCR) (r = 0.418; P < 0.001) and MLG (r = 0.771; P < 0.001). In the non-white women, REE was only significantly correlated to MLG (r = 0.753; P < 0.001). The multiple linear regression analysis showed that skin color, MLG and PCR were the significant determinants of REE (R<sup>2</sup> = 0.55). This study showed that, after adjustment for MLG, non-white severely obese women have a higher REE than the white ones. The association of body composition inflammation factors and REE in severely obese Brazilian women remains to be further investigated.

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Key words: Air displacement plethysmography. Body composition. Ethnic differences. Energy expenditure. Obesity.

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## GASTO ENERGÉTICO EN REPOSO DE MUJERES OBESAS SEVERAS BLANCAS Y NO BLANCAS

Resumen

El presente estudio tenía como objetivo comparar el gasto energético en reposo (GER) de mujeres brasileñas obesas severas, blancas y no blancas. Se examinó el GER en 83 mujeres brasileñas obesas severas (n = 58 blancas y 25 no blancas) con un promedio de edad (± SD) de 42,99 ± 11,35 e índice de masa corporal de 46,88 ± 6,22 kg/m<sup>2</sup>, que serían sometidas a cirugía de bypass gástrico. Se evaluó la composición corporal por medio de una pletismografía por desplazamiento de aire (ADP) BOD POD<sup>®</sup> sistema de composición corporal (de Life Measurement Instruments, Concord, California, EE.UU.) y se evaluó el GER, de acuerdo con el protocolo establecido, con un calorímetro de circuito abierto (fabricado por Deltatrac II MBM-200, Datex-Ohmeda, Madison, Wisconsin, EE.UU.). No se encontraron diferencias significativas entre el GER de mujeres obesas severas blancas y no blancas (1.953 ± 273 y 1.906 ± 271 kcal/d, respectivamente; p = 0,48). Sin embargo, al ajustarse en masa libre de grasa (FFM, por sus siglas en inglés), el GER fue considerablemente superior en mujeres obesas severas no blancas (diferencia de 158,4 kcal, p < 0,01 entre los grupos). El GER de las mujeres blancas mostró una correlación positiva y significativa con la proteína C-reactiva (CRP) (r = 0,418; P < 0,001) y FFM (r = 0,771; P < 0,001). En las mujeres no blancas, el GER mostró una correlación positiva sólo con FFM (r = 0,753; P < 0,001). El análisis de regresión lineal múltiple arrojó que el color de la piel, FFM y CRP eran factores significativamente determinantes de GER (R<sup>2</sup> = 0,55). El presente estudio reveló que, después de realizar el ajuste para FFM, las mujeres obesas severas no blancas tienen un GER superior al de las blancas. La asociación entre los factores de inflamación de la composición corporal y el GER en mujeres brasileñas obesas severas es un tema que se debe seguir investigando.

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Palabras clave: Pletismografía por desplazamiento de aire. Composición corporal. Diferencias étnicas. Gasto energético. Obesidad.

## Introduction

The association between the excess of body fat mass and higher coronary heart disease incidence,<sup>1</sup> hypertension, dyslipidemia, hyperinsulinemia and type-2 diabetes prevalence<sup>2</sup> is well known. Obesity is considered a serious public health problem, affecting a significant proportion of people from all ages and different origin. The National Center for Health Statistics, Centers for Disease Control and Prevention, reported that 32.2% of American adults were obese (body mass index [BMI] > 30) during 2003-2004. This is an increase from 22.9% report for 1988-1994.<sup>3</sup> The obesity incidence in Brazil increased 1% in 2003 and affect 13.1% of Brazilian women.<sup>4</sup>

The prevalence of obesity, in United States, seems to be higher in African-American women (49%) than in Caucasian women (34%).<sup>5</sup> Moreover African-American women experience a major weight gain (> 10 kg) over a period of 10 year than Caucasian women and have 60% more chance to become obese.<sup>6</sup>

Some researchers suggested that the resting energy expenditure (REE) of Caucasian women is higher than African-American women.<sup>7</sup> This difference may explain why obese African-American women are less likely to lose weight than Caucasian women and are likely to regain lost weight.<sup>8</sup>

REE is the main component of total energy expenditure (TEE), contributing with 60-70% of the TEE in most individuals. REE is influenced by gender, height, weight, age, health status and body composition (mainly fat free mass (FFM)).<sup>9</sup>

On the other hand African-American have similar or smaller amounts of total body fat and greater amounts of bone and skeletal muscle mass which not explain a lower REE.<sup>7</sup> Several researchers have reported lower levels of physical activity,<sup>10</sup> relatively low volumes of metabolically active organs,<sup>11</sup> and higher rates of sedentary lifestyle in African-American women compared to Caucasian women. Besides severe obese patients are characterized by a chronic inflammation which is associated with an increase REE.<sup>12</sup>

Although it is apparent that cultural and behavioral differences exist between ethnics, it is still important to determine if there are racial metabolic differences that may contribute differentially to adiposity levels.

Historically, population from Brazil is the result of a mixture of people from different origins-native's indians, Europe and, Africa. Nowadays, the Brazilian people results in a fusion of these three human origins. This particular miscegenation, white and non-white Brazilian women may have particular characteristics different of other African-descendent or Caucasian women.

However there is little information available about the possible association between resting energy expenditure, inflammation, body composition in severe obesity incidence and ethnic in women. Considering that North American studies are suggesting that there is

higher obesity prevalence in African-American women with due to a decreased REE in relation to Caucasian women, it is interest to compare the REE of severe obese Brazilian white and non-white women.

## Methods and procedures

Severely obese women candidate to gastric bypass surgery (n = 58 white and n = 25 non-white) participated in this study. Exclusion criteria women younger than 18 years old, or with cancer, coronary heart disease, hepatic or pulmonary failure, chronic kidney disease, impaired thyroid function, or who were pregnant or breast-feeding and physical activity person.

The present investigation was developed at the Department of Gastroenterology, Surgical Division from the University of São Paulo, Medical School, and the study protocol was approved by the Ethical Committee from Clinics Hospital and School of Medicine. Written Informed consent was obtained from each patient prior to her participation in the study.

## Methods

### *Study Protocol*

Prior to enrollment, all patients were interviewed in order to verify the inclusion/exclusion criteria, explain instructions of the study protocol, and to obtain written informed consent. The patients were separately in two groups by the skin color: white and non-white severely obese women by the observation of the same technician. Patients underwent anthropometrical and, body composition assessments and REE measurement.

### *Anthropometrical assessment*

The anthropometrical measurements were performed in the morning of the same day of the REE measurement and body composition assessment, and included total body weight and height determinations. Body weight was measured to the nearest 0.01 kg using the air displacement plethysmography (ADP) scale, which were calibrated daily using two standard 10-kg weights. Height was measured to the nearest 0.1 cm using the stadiometer, model Sanny®, Brazil, with subjects standing erect without shoes. Body mass index (BMI) was calculated as body weight (in kg) divided by squared height (in meters).<sup>13</sup>

### *Resting energy expenditure (REE) measurement*

REE was measured by indirect calorimetry with the use of an open-circuit, ventilated, computerized metabolic system (Deltatrac Monitor II MBM-200, Datex-

Engstrom Division, Instruments Corp. Helsinki, Finland). Before each REE measurement, the oxygen and carbon dioxide sensors were calibrated by using mixed reference gases of known composition. All subjects had been instructed to maintain their regular medication, to refrain from any unusual physical activity in the 24-h period before the test, and to maintain their usual sleep schedule the night before REE measurement. They were admitted to the clinic in the morning after a 12 hours overnight fast. After 30 min of rest in a recumbent position, subjects breathed through a clear plastic canopy, placed over their heads, for 35 min in a quiet, dimly lit, thermally neutral room. They were instructed to avoid hyperventilation, fidgeting, or falling asleep during the test. Oxygen consumption ( $\text{VO}_2$ ) and carbon dioxide production ( $\text{VCO}_2$ ) were measured at 1-min intervals, and the mean of the final 30 min was used to calculate REE without using the urinary urea nitrogen, according to the Weir equation<sup>14</sup> as follows:

$$\text{Basal metabolic rate (BMR) (kcal/min)} = 3.9 [\text{VO}_2 (\text{L/min})] + 1.1 [\text{VCO}_2 (\text{L/min})]$$

where  $\text{VO}_2$  is volume of oxygen and  $\text{VCO}_2$  is volume of carbon dioxide.

$$\text{REE (kcal/d)} = \text{BMR} \times 1.440 \text{ min}$$

#### Body Composition Assessment

Body composition was measured by ADP (BOD POD®; Life Measurement Inc, Concord, California, USA). Procedures for ADP have been explained in detail elsewhere.<sup>15,16</sup> Briefly, before each trial, the ADP was calibrated using a 50.341-L cylinder. All subjects were tested wearing minimal, tight-fitting clothing (swimming suit or bra and panties for women and underpants for men) and swimming cap to compress the hair.<sup>17,18</sup> Measured thoracic gas volume was used to calculate a corrected body volume (corrected body volume = raw body volume - thoracic gas volume). Body density was calculated as body mass divided by the corrected body volume.<sup>19</sup> Body fat (BF, in kg) was calculated as % BF multiplied by total body mass obtained on the digital scale. Fat-free mass (FFM, in kg) was calculated from body weight minus BF. Patients had been instructed to not smoke or not drink alcohol on the day of the assessment. The same trained technician evaluated all patients.

#### Biochemical data

All patients had blood drawn under fasting condition. The C-reactive protein (CRP) was determined by Nefelometric High Sensitivity CRP, Dade Behring, Marburg, Germany.

**Table I**  
Characteristics of the subjects

	White (n = 58)	Non-white (n = 25)	P value
Age (years)	44.43 ± 10.91	39.64 ± 11.82	0.08
Height (cm)	158.00 ± 0.06	160.00 ± 0.08	0.24
Body Weight (kg)	113.94 ± 17.06	117.02 ± 19.00	0.47
BMI (kg/m <sup>2</sup> )	45.47 ± 5.28	45.64 ± 6.08	0.90
Body fat (%)	53.51 ± 4.49	51.07 ± 4.95	0.03
Body fat (kg)	61.29 ± 12.39	60.38 ± 14.21	0.77
Fat free mass (%)	46.48 ± 4.48	48.93 ± 4.95	0.03
Fat free mass (kg)	52.65 ± 7.20	56.68 ± 6.92	0.02
CRP (mcg/ml)*	9.42 (28.0 to 1.10)	7.18 (41.9 to 0.22)	0.133

Values are mean ± standard deviation. BMI = body mass index; CRP = C reactive protein.

\*Median and range.

#### Statistical methods

Data are expressed as mean ± standard deviation (SD) for normal distribution variables and as median and ranges for variables that did not present normal distribution.

Comparisons between the two groups were assessed for continuous variables with a Student's unpaired *t* test and the Mann-Whitney *U* test when the variable had normal or non normal distribution, respectively. Pearson and Spearman correlation coefficients were used to determine the linear correlation with REE, CRP and FFM. The multiple linear regression analysis was applied to evaluate the determinants of REE in the two groups. A *p* value < 0.05 was considered statistically significant for all tests. The statistical analyses were performed using SPSS, version 11.01, Inc, Chicago, IL, EUA.

#### Results

The main characteristics of white and non-white severely obese women are shown in table I. Age, body weight, height, BMI and CRP were similar between the groups. FFM was significantly lower in white women when compared to non-white women.

The REE did not differ between groups (white: 1,953.45 ± 273 kcal/day vs non-white: 1,906.80 ± 271 kcal/day; *P* = 0.48). Also the ratio REE/kg of body weight was not different between groups (white: 17.25 ± 1.69 kcal/kg vs non-white: 16.49 ± 2.28 kcal/kg; *P* = 0.10). However the ratio REE/kg of fat free mass in white women was significantly higher than in non-white women (37.32 ± 4.28 kcal/kg vs 33.71 ± 3.16 kcal/kg; *P* < 0.01, respectively). The multiple linear regression analysis for the adjusted for FFM found a significant difference of 158.4kcal between groups (*P* < 0.01) in the figure 1.

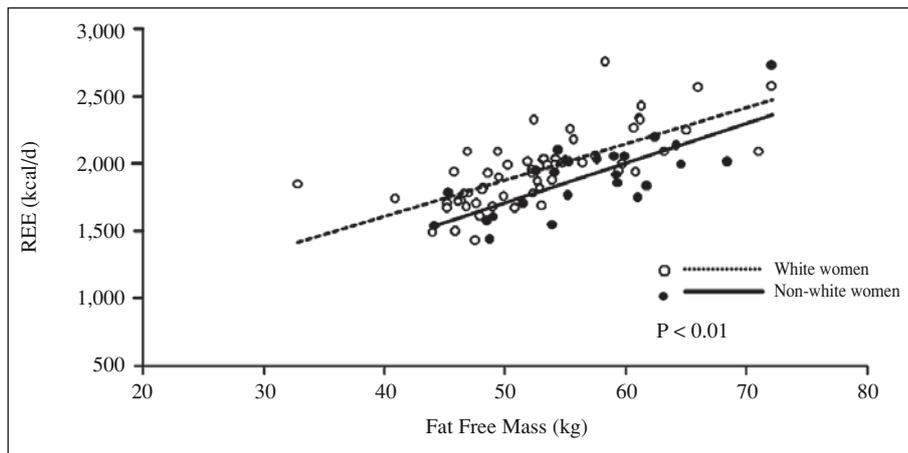


Fig. 1.—Comparison of REE adjusted for fat free mass in white and non-white severely obese women.

REE was significantly correlated with CRP measurements for the white severely obese women group ( $r = 0.491$ ;  $P < 0.001$ ), but not for the non-white severely obese women ( $r = -0.242$ ;  $P = 0.241$ ). Moreover, REE was positively correlated with FFM (in kg) in white and non-white severely obese women group ( $r = 0.711$ ;  $P < 0.001$ ;  $r = 0.753$ ;  $P < 0.001$ , respectively). The CRP was negatively correlated with % FFM in white women ( $r = -0.326$ ;  $P = 0.013$ ) and non-white women ( $r = -0.518$ ;  $P < 0.001$ ). FM (in kg) was also positively correlated with CRP only in white women ( $r = 0.402$ ;  $P < 0.001$ ), but not in non-white women ( $r = 0.278$ ;  $P = 0.178$ ).

When a multiple linear regression analysis was performed using the skin color, FFM and CRP as independent determinants, the final model revealed that all these variables were significantly associated with REE ( $R^2 = 0.5483$ ; table II). This analysis showed that the REE of non-white severely obese women is 144.29 kcal lower of the white group. Besides there is a increased of 27.11 kcal for each kilogram of FFM and each unit of CRP increase 6,87 kcal in REE. The skin color is the variable that most contributed with REE.

## Discussion

The present study aimed to compare the REE in white and non-white severely obese women. The

**Table II**  
Multiple linear regression analysis using REE as the dependent variable for white and non-white severely obese women (adjusted  $R^2 = 0.5483$ )

Variable	Coefficient (kcal)	95% confidence interval	P value
Ethnic	-144.29	45.92 to -3.14	<0.01
Fat free mass (kg)	27.11	2.88 to 9.41	<0.01
CRP (mcg/ml)	6.87	2.59 to 2.66	<0.01
Intercept	446.88	154.19 to 2.908	<0.01

Brazilian population is well-known to be a mixture of different people (native's indigenes, Caucasian, African, European and a mixture of them). The progressive increase prevalence of obesity in Brazil justifies studying the potential differences on REE in white and non-white Brazilian obese women.

The results of the present study show that REE of white and non-white Brazilian severely obese women differs only after adjusted by FFM. Few studies have measured REE in white and non-white severely obese women. Kushner et al.<sup>20</sup> have demonstrated that REE of Caucasian obese women was similar to that of American-African women. The authors have speculated that the small sample size (n. 14 and 15 per group) could be one of the possible explanations for the absence of no difference in REE between the groups. Furthermore, these researchers have not taken into consideration period of the menstrual cycle which is responsible for a significant fluctuation of up to 10% in metabolic rate between the phases of the menstrual cycle.<sup>21,22</sup> In our study all of the women were in a follicular phase of the menstrual cycle which not explains the difference in REE between two groups.

Two studies are in agreement with our own study that has demonstrated that REE of non-white obese women was lower to that of white obese women. In the Forman study the REE of African-American severely obese women was 12% lower than Caucasian severely obese women.<sup>23</sup> In the Foster study the REE of African obese women was 5% lower than Caucasian obese women. When these values were adjusted by FFM this difference was 8%.<sup>24</sup>

In the present observation the exact factors affecting REE of the two groups cannot be clearly identified, but some possibilities can be raised. Some authors speculate that the REE of obese patients could be affected by FFM,<sup>25,26</sup> age, heart rate, high metabolic rate organs,<sup>7</sup> insulin and leptin rate, inflammation and ethnic.<sup>27</sup>

In the present study, REE were different comparing the two groups after adjustment of FFM. In white severely obese women the FFM and CRP were correlated with REE but in non-white severely obese women

only FFM was correlated with REE. FFM is a well-known determinant of REE in healthy subjects as well as in patients with various clinical conditions.<sup>28</sup> In fact, FFM explains about 20 to 30% of the variations of REE.<sup>29</sup> Obesity is accompanied by generalized inflammation, characterized by increased plasma CRP levels as well as by dysregulated cytokine production by monocytes, lymphocytes and other immune cells.<sup>30,31</sup>

Although there was no difference in CRP between the groups, a significant correlation was found between REE and CRP and FFM only in white severely obese women. So we could speculate that these white women may have some degree of inflammation not found in non-white severely obese women. More studies are necessary to elucidate the exact factors that influence the REE in non-white and white severely obese women.

The limitations of the present study include the different and small sample size of the two groups. That could explain the absence of the difference in CRP between the groups.

At conclusion, our findings showed that REE of non-white severely obese women are lower from those white severely obese women. The correlation of CRP and REE found only in white women remain to be further investigated.

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## Disclosure Statement

There is no potential conflict of interest in this study.

## Authorship

LMH was responsible for conception, design, data collection, results interpretation, and the writing of the manuscript, and the statistical analysis. MCG contributed to the results interpretation, writing of the manuscript, statistical analysis and reviewing the manuscript. MR contributed to the design of the study. RST contributed to the research design and the writing of the manuscript. NLR contributed to the data collection. CCGV contributed to the data collection. IC contributed to interpretation of the results. SBH contributed to the reviewing of the manuscript. DLW contributed to the conception and reviewing of the manuscript. None of the authors had any personal or financial conflict of interest.

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