Dietary Re-education, Exercise Program, Performance and Body Indexes Associated with Risk Factors in Overweight/Obese Women

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ASTRACT

This study observed the effect of a dietary re-education plus regular physical activity on body composition, risk factors and physical test performance of sedentary overweight/obese women and to correlate these variables one with each other. Fifty women (36±10 yrs; 31±6 body mass index (BMI, kg/m^2)) volunteered for the study. Body compositions were obtained by anthropometry and bioimpedance and some body indexes were established. One-repetition maximum (1-RM) and treadmill VO_2max tests were carried out and blood samples were obtained for lipid, glucose and uric acid analyses before (T1) and after two months of intervention (T2). Diet was established by indirect calorimetry. Body fat, glucose, uric acid, total cholesterol, HDL-cholesterol and systolic blood pressure were significantly reduced. The 1-RM and VO_2max tests were significantly increased. Neck circumference (NC) was correlated with body composition, back muscle 1-MR, HDL and LDL cholesterol, total cholesterol/HDL ratio, uric acid, and resting energy expenditure. BMI was found to be significantly correlated with waist/hip ratio, circumference sum, and body fat percentage by anthropometry and bioimpedance. Body fat percentage determined by bioimpedance and anthropometry was significantly correlated with arm fat area and arm fat area corrected respectively, and both with BMI at T1 and T2. This study suggests that a dietary reeducation plus physical activity around 200 min/week improved body composition and the health of these women. Many anthropometry measurements have correspondence to risk factors and NC could be a simple approach to reflect these results, without other more complex techniques. ***Journal of the International Society of Sports Nutrition****. 2(2):45-53, 2005*

Key Words: blood lipids, 1-RM, anthropometry, bioimpedance, BMI.

INTRODUCTION

Overweight and obesity is a worldwide public health problem [1] and its great increase is mainly due to the increase in energy consumption owing to the availability of highly palatable foods of high caloric density and to the reduction of energy expenditure by regular physical activity [2]. Furthermore, obese individuals have a low physical conditioning [3], which in addition to obesity, are associated with increased morbidity and mortality [4]. The method of choice used to determine whether weight is adequate is the calculation of body mass index (BMI, kg/m^2), which ranges from malnutrition to grade III obesity [5]. However, fat content, which is the most important factor in terms of associated chronic diseases, may oscillate widely within the same BMI value. There are various methods and formulas for the evaluation of body composition, which may involve a high magnitude of intra- and inter-subject variation [6]. In addition, several body indexes such as abdominal circumference (AbC) [7], waist/hip ratio (WHR) [2] and BMI [5] are related to risk factors but they evaluate only one compartment and do not estimate fat or lean mass content or the evolution of these components within a given treatment. The assessment of body fat and of its distribution is of help in the prediction of correlated problems and in the monitoring of the course of programs of body weight reduction [8].

Anthropometry has the advantage of being a measuring tool involving less time and operational costs than other more complex methods. However, there are several possibilities of measurement errors, with the need for an operator properly trained in the use of anthropometry based on international techniques [8]. In contrast, the measurement of neck circumference (NC, cm) is very simple, can be performed by a less trained person and only requires a measuring tape. NC can be a simple and promising measure for the indication of excess body fat and may be associated with risk factors. NC has been positively correlated with arterial pressure, metabolic syndrome factors [9], risk of coronary artery disease [10], and values ≥ 37cm for men and ≥ 34cm for women regarding overweight and obesity [11].

Thus, the major objectives of the present study were: 1) to determine the effects of two months of dietary reeducation plus regular physical activity on body composition variables, risk factors, and physical performance; 2) to compare NC to other methods of body composition; tests of physical performance; biochemical blood markers of risk; and resting energy expenditure; and 3) to compare the various methods of evaluation of body composition to one another to determine their correspondence.

MATERIALS AND METHODS

Study Design. The subjects were stimulated to practice physical activity in circuit or as jogging 60 min x 3 d/wk in the first month and 60 min x 4 d/wk in the second. They were instructed to consume a diet close to the value of their daily resting energy expenditure (REE). Weekly meetings were scheduled with a professional staff for recommendations about diet and exercise. The staff consisted of a physician, two physical educators and a nutritionist. Initial (T1) and final (T2) evaluations were performed. Blood samples were collected for the determination of lipids, uric acid and glucose. REE was calculated by indirect calorimetry, and anthropometric measurements, bioimpedance and physical tests were performed.

Subjects. The selected subjects were overweight or obese (BMI > 25 kg/m^2; Table 1) sedentary (less than two sessions/wk of formal or informal physical activity in the last semester) women that had no metabolic disease in addition to obesity itself, and had no orthopedic limitations. All were examined by a doctor from the Nutrology team of the Department of Internal Medicine, Faculty of Medicine of Ribeirão Preto, University of São Paulo (FMRP-USP). The Research Ethics Committee of FMRP-USP approved the study and all subjects were informed about the procedures of the study and signed written informed consent to participate.

Interventions. Circuit training consisted of 15 stations of resisted exercises for all muscle groups, distributed in a circle in a 10 x 15 m room with a pad on the floor. Warm-up consisted of combined walking and simultaneous stretching (10 min); each exercise was performed over a period of 30 s intercalated with 30 s of walking/jogging over a total period of 40-45 min. The exercise at each station was performed until the end of the scheduled time or the occurrence of muscle exhaustion. After completion of the circuit, the subjects cooled down with stretching of the muscle groups exercised followed by induced relaxation (10 min). Jogging followed the same pattern of distribution, with the central part of the program consisting of continuous jogging for 40 to 45 min. Both protocols were executed in the intermediate zone of heart rate (HR) (60 to 70% maximum HR) estimated by the formula 220 – age, measured by pulse palpation after warm-up, in the middle of the session and before the return to rest. In order to maintain an equal intensity throughout the session, the Borg scale was also used between values of 13 to 14 (somewhat hard to hard) [12].

The habitual diet of the participants was adjusted to the REE measured by indirect calorimetry and balanced according to the macronutrients (20% of fat; 20% of protein; 60% of carbohydrate). The habitual ingestion was obtained by means of a one-week dietary record performed before (T1) and after (T2) the interventions. One table for the evaluation of dietary consumption was used to convert household measures to grams [13], and then converted to food chemical composition [14]. The subjects were instructed to avoid the consumption of simple sugars, especially glucose and fructose [15], and of saturated fat [16].

MEASUREMENTS

Anthropometry. All anthropometric measurements were made by one of the authors (C.A.F) using the standard techniques described by Navarro and Marchini [8]. Body weight (kg) and height (cm) were measured using a Filizola® Eletrônica ID 1500 scale (São Paulo, SP, Brazil) with 0.1 kg precision (up to 150 kg) and 0.5 cm precision (up to 2.10 m), respectively. Skinfolds (SF) were measured with a Lange® adipometer (Beta Technology, Santa Cruz, CA, USA) with a constant pressure of 10 g/mm^2 on

Table 1. Clinical characteristics of the study subjects before (T1) and after (T2) the interventions

Variables/Times	T1 mean ± SD (n)	T2 mean ± SD (n)
Age	36 ± 11 (50)	-
Height	164 ± 6 (50)	-
Weight	83 ± 16‡ (50)	77 ± 16 (27)
BMI	31 ± 6‡ (50)	29 ± 6 (27)
Body fat % by anthropometry	42 ± 6‡ (50)	36 ± 6 (27)
Body fat % by bioimpedance	40 ± 6 (46)	38 ± 6 (18)
Glucose (mg/dL)	93 ± 10† (46)	89 ± 6 (21)
Uric acid (mg/dL)	5 ± 1* (48)	4 ± 1 (22)
Total cholesterol (mg/dL)	184 ± 29* (48)	178 ± 27 (22)
Triglycerides (mg/dL)	105 ± 52 (48)	87 ± 35 (22)
HDL-Cholesterol (mg/dL)	55 ± 12* (48)	52 ± 12 (22)
LDL-Cholesterol (mg/dL)	108 ± 27 (48)	105 ± 18 (22)
Systolic blood pressure (mmHg)	124 ± 20† (49)	117 ± 14 (24)
Diastolic blood pressure (mmHg)	80 ± 13 (49)	76 ± 10 (24)
1-RM bench press (kg)	44 ± 12‡ (42)	49 ± 11 (21)
1-RM seated low row (kg)	35 ± 5‡ (42)	41 ± 6 (21)
1-RM leg press (kg)	80 ± 21‡ (42)	88 ± 21 (21)
VO_{2max} (L/min)	34 ± 2‡ (24)	40 ± 2 (18)

Statistics: data are reported as means ± SD; n = number of subjects per test. Paired *t*-test; only diastolic blood pressure was evaluated by the paired Wilcoxon test. T1 versus T2: * $P \leq 0.05$; † $P \leq 0.005$; ‡ $P \leq 0.0001$. 1-RM: 1-repetition maximum tests; VO_{2max} : maximum oxygen consumption.

the contact surface and 1 mm precision and with a 0-65 mm scale for the measurement of subcutaneous adipose tissue. The mean of 3 consecutive measurements was recorded. The following SF were measured: triceps, biceps, subscapular, suprailiac crest, pectoral, abdominal, thigh and calf. Body density was calculated by the equation of Jackson et al. [17] for three SF for women corrected for age and then converted to body fat percentage (%FA) by the equation of Siri [18]. The sites of the measurements were the same as used in the reference for body density. Fat mass and lean mass were then calculated from them. The following circumferences were measured (cm): extended arm obtained at the midpoint of the length of the humerus; forearm in its largest circumference; wrist at its narrowest point; neck (NC) measured in the middle height of the neck; waist measured at the narrowest point between the last rib and the iliac crest; abdominal (AbC) over the umbilical scar; hip measured over the greater trochanter; thigh, measured with the subject standing up parallel to the floor immediately below the gluteal fold; calf obtained in its largest portion with the subject standing up. We used a flexible, non-extensible plastic tape with 0.1 cm precision according to standard techniques. The waist/hip ratio (WHR) was obtained by the division of Ab/hip circumferences. The Ab circumference was chosen instead of the waist circumference because its fat content is more representative than that of the waist circumference.

The muscle circumference of the arm was obtained (in cm) by subtracting arm circumference from triceps fold multiplied by π [19]. The area of arm fat was calculated from the anthropometric measurements [19] and then corrected according to the estimate obtained by computed tomography, and the result was multiplied by 1.249 [20] according to the formula below:

1). $AFA = ((2 \times TF \times AC) - (\pi \times TF^2)) \div 4$

Where: AFA = arm fat area (cm^2), TF = triceps skinfold (cm), and AC = arm circumference (cm).

Bioimpedance (BIA). BIA was determined using a Quantum BIA-101Q®, Serial n Q 1559 apparatus (RJL Systems, Inc. Clinton, MI, USA), with a frequency of 50 kHz of 4-electrode alternate current. The formula validated by Segal et al [21] was used to determine lean mass, and body fat percentage (%FB) and fat mass were calculated from lean mass and weight.

Blood biochemistry. The hemogram was determined in the Hematology Laboratory using an STKS Coulter® counter (Hialeah, Fl, USA) and the lipidogram [22-24] was also determined in the same laboratory. LDL-cholesterol was calculated using the following formula [9]:

2). $LDL = CT - HDL - Tg / 5$

where: LDL = low density lipoprotein-cholesterol, TC = total cholesterol, Tg = triglycerides, HDL = high density lipoprotein-cholesterol (all reported in mg/dL).

Uric acid was determined by the uricase method, modified, and glycemia by an adaptation of the hexokinase-glucose-6-phosphate method in the Central Laboratory of the University Hospital, FMRP-USP.

Resting energy expenditure (REE). All calorimetric measurements were performed by C.A. Fett and W.C.R. Fett on subjects submitted to a 12 h fast. A mobile Vmax. 29 Sensor Medics® instrument (Yorba Linda, CA, USA), was used for data analysis. After arriving at the laboratory, the subjects rested for 30 min in the sitting position and for an additional 30 min in the supine position, after which REE was estimated for 30 min. The volunteers were instructed to remain in absolute rest, also avoiding conversation, but were not allowed to go to sleep. Daily REE was calculated by the equation of Weir [25].

One repetition maximum tests (1-RM). The tests were carried out as previously described [26]. The subjects were instructed and counseled by Physical Education (C.A. Fett and W.C.R. Fett), specialists in weight training. Test 1: bench press (triceps, shoulders and chest); Test 2: leg press (thighs and glutei); Test 3: seated low row (biceps, shoulders and back).

Maximum oxygen consumption (VO_{2max}). Two electric treadmills (E17A, Del Mar Reynolds Medical, Inc., Irvine, CA, USA, and KT 10200, Inbramed, Porto Alegre: RS, Brazil) and the Ergo SF13 and digital ECG programs of Micromed (Micromed Biotecnologia Ltda. Guará II, Brasília, DF, Brazil) were used. The tests were carried out in the ergometry room of the Cardiology Section of the University Hospital, FMRP-USP by the staff of the cardiology service of this institution using the Bruce protocol [27].

Data Analysis. The mean data obtained at the beginning of the study (T1) were compared to those obtained at the end (T2) by the paired Student *t*-test in the presence of normal distribution, or by the paired Wilcoxon test when distribution was not normal. Pearson linear correlation was calculated for normal distribution and Spearman correlation was calculated when distribution was not normal. The correlation of the variations between T1 and T2 were also calculated for two measures (Δ = T2-T1). Multiple linear regressions were used to determine the association between some variables. Data for comparison of the means are reported as means $\pm$ SD and individual values were used to calculate the correlations and regressions. The level of significance was set at 5% in all analyses, with a 95% confidence interval [28].

RESULTS

Subjects. The general characteristics of the subjects determined at the two times of the study (T1 and T2) are listed in Table 1. Of the 50 women who started the study, 27 completed it. The reasons for the 23 drop-out cases were: little adherence to diet or exercise (N = 9), difficulties about the training time schedule due to job or family reasons (N = 6), family disease (1), a fall (1), and depression and/or anxiety (N = 6). The treadmill test was applied to 24 subjects and calorimetry to 28 at T1. The number of subjects was not constant in the other tests due to subject failure to appear for one or another test. The specific number for each topic is reported in the tables and figures.

Results of the interventions. The weight, BMI, body fat percentage anthropometry, glucose, uric acid, total cholesterol and HDL-cholesterol demonstrated a significant reduction, including NC. Systolic blood pressure (SBP, mmHg), was reduced and diastolic blood pressure (DBP, mmHg), was unchanged. The three strength tests and maximum oxygen consumption (VO_{2max}) increased significantly (Table 1).

Correlation of neck circumference with other variables. NC correlated with weight, percent body fat determined by bioimpedance and anthropometry, with REE, skinfold sum, circumferences sum, BMI, lean body mass calculated by anthropometry and bioimpedance at T1 and T2, and arm muscle circumference calculated only at T1 (Table 2). The REE, biochemical variables, blood pressure, and strength tests were compared only at the beginning of the study (T1). There was a significant correlation of NC with uric acid, HDL and LDL cholesterol, total cholesterol/HDL, and 1-RM of seated low row (Table 3). Only the variations (Δ) in NC and REE between T1 and T2 were correlated.

Relation between body indices. BMI, WHR, the sum of the circumferences, %FA, and %FB showed a significant linear correlation. When analyzed pairwise it demonstrated significant Pearson linear correlation: BMI x WHR: $r = 0.58$, $r^2 = 0.34$, $P < 0.0001$; BMI x sum of the circumferences: $r = 0.95$, $r^2 = 0.90$. $P < 0.0001$; BMI x %FA: $r = 0.69$, $r^2 = 0.48$, $P < 0.0001$; BMI x %FB: $r = 0.74$, $r^2 = 0.55$, $P < 0.0001$; WHR x sum of the circumferences: $r = 0.46$, $r^2 = 0.21$, $P = 0.0013$; WHR x %FA: $r = 0.46$, $r^2 = 0.21$, $P = 0.0012$; WHR x %FB: $r = 0.41$, $r^2 = 0.16$, $P = 0.0052$; %FA x %FB: $r = 0.54$, $r^2 = 0.29$, $P = 0.0001$. %FA was significantly correlated with corrected arm fat area, and %FB was significantly correlated with arm fat area at both times. %FA and %FB were significantly correlated with BMI at both times (T1 and T2).

DISCUSSION

In general, the results of the present study showed a significant reduction in body weight and fat, an improvement in the biochemical blood profile, a reduction of SBP, and an improvement of general physical condition (strength and aerobic) after intervention with a dietary and physical activity reeducation. Taken together, these changes reduce the risk of chronic diseases and morbidity/mortality, even in individuals who continue to be obese [2,4]. In addition, a significant correlation was observed between NC, percent body fat, and anthropometric indexes of independent risk of morbidity and mortality both before and after weight reduction. Before the intervention, NC was also correlated with various biochemical blood risk factors and with a physical test. Several studies have reported a positive association between NC and various risk factors for cardiovascular diseases [9-11, 29].

The result of the physical conditioning of these obese women was very positive, since these women usually have a low tolerance to physical activity [3], which impair progress in weight reduction programs. The control of overweight is obtained by the coordination between the effects of energy intake and energy expenditure mediated by endocrine and nervous signals, which are stimulated by physical activity [2]. In addition, several risk factors were reduced with the improvement of physical performance, with a consequent reduced chance of morbidity and mortality. It has been demonstrated that active obese individuals have a lower chance of mortality than individuals of normal weight but who are sedentary [4].

No volunteer received a diet with less than 1100 kcal/d in either group. The option was for a moderate calorie reduction since a very low calorie diet reduces or eliminates thermic effect of food in obese women regardless of the concentration of macronutrients administered [30]. In addition, a moderate diet has been demonstrated to be more efficient than VLCD by inducing a greater loss of stored body fat by kilocalorie deficit [31]. The present results show that this approach is reliable.

The increase in BMI and body fat *per se* is associated with chronic diseases and a reduction in life expectancy [8]. Other anthropometric measurements such as AbC [7] and WHR [2] are also associated with risk factors and were significantly correlated with each other in the present study. In addition, direct measurements of subcutaneous fat thickness such as skinfolds were found to be associated and correlated with BMI, WHR and body fat percentage according to the methods used. Body fat percentages calculated by bioimpedance and by anthropometry, as well as the sum of 3 or 8 skinfolds were positively associated with NC at both time points. Other studies have also reported a good correlation between NC and body fat indicators [9-11].

Table 2. Relation of neck circumference to other variables before (T1) and after the interventions (T2)

Variables	Subjects (n)	NC (cm) at T1 or T2		
		r	r^2 or CI	p
Weight (kg) T1	49	0.78	0.61	0.0001*
Weight (kg) T2	27	0.79	0.63	0.0001*
Δ weight (kg)	27	0.002	2.35E-06	0.9940¶
Body mass index (kg/m^2) T1	49	0.71	0.05	0.0001*
Body mass index (kg/m^2) T2	27	0.68	0.47	0.0001*
Δ Body mass index (kg/m^2)	27	0.30	0.09	0.1270¶
Body fat % by anthropometry T1	50	0.61	0.37	0.0001*
Body fat % by anthropometry T2	27	0.60	0.36	0.0010
Δ body fat % by anthropometry	27	0.33	0.12	0.0917¶
Body fat % by bioimpedance T1	45	0.64	0.40	0.0001*
Body fat % by bioimpedance T2	20	0.74	0.54	0.0002*
Δ body fat % by bioimpedance†	20	0.10	-0.53 to 0.37	0.6648¶
Fat mass by anthropometry (kg) T1	49	0.65	0.42	0.0001*
Fat mass by anthropometry (kg) T2	27	0.71	0.50	0.0001*
Fat mass by bioimpedance (kg) T1	48	0.67	0.45	0.0001*
Fat mass by bioimpedance (kg) T2	20	0.90	0.81	0.0001*
Sum of 3 skinfolds (mm) T1	50	0.63	0.40	0.0001*
Sum of 3 skinfolds (mm) T2	27	0.63	0.40	0.0004*
Sum of 8 skinfolds (mm) T1	50	0.69	0.48	0.0001*
Sum of 8 skinfolds (mm) T2	27	0.67	0.46	0.0001*
Abdominal circumference (cm) T1	50	0.67	0.46	0.0001*
Abdominal circumference (cm) T2	27	0.62	0.38	0.0006*
Waist/hip ratio T1	50	0.48	0.23	0.0004*
Waist/hip ratio T2	27	0.41	0.17	0.0320*
Arm muscle circumference (cm) T1	50	0.28	0.08	0.0450*
Arm muscle circumference (cm) T2	27	0.16	0.02	0.4225¶

Statistics: most variables presented Gaussian distribution and therefore Pearson linear correlation was used; † Spearman correlation. *Significant; ¶Nonsignificant. CI: confidence interval. Δ: variation (T2-T1) of the variables in question.

Furthermore, body fat percentage is a more selective measurement than BMI, WHR, AbC, or NC since, in the increase in total body mass, it separates lean mass content from fat mass [32]. Measurements of a single compartment, such as BMI, may present wide variation in terms of body fat percentage. For example, it was demonstrated that for a BMI of 25, body fat percentage measured by dual-energy x-ray absorptiometry might range from 20 to 50% [6]. In addition, in a study on subjects divided into age ranges from 18 to 79 years, body fat percentage was found to increase with age even when BMI was within the normal range [33]. But, as also reported by others [34], we observed a significant correlation between BMI and body fat percentage calculated by the two methods, and other indicators of body fat distribution in these obese women. However, the variation of agreement between these measurements was 34% to 91%, demonstrating a marked fluctuation. In contrast, NC compared to the same variables of body fat percentage was more stable, showing neither elevated nor very low values, suggesting that this measurement could be a good indicator of body fat. However, we do not know if NC would behave like BMI regarding aging. The best method and index for the assessment of obesity and associated risk factors is still a source of debate in the literature.

Several blood biochemistry risk factors were significantly correlated with NC in the present study. In contrast, glucose, SBP and DBP showed no significant correlation. Other studies have observed that NC is correlated with age, weight, hip circumference, cut-off values of BMI for overweight and obesity, [11] AbC, WHR, total cholesterol, LDL, triglycerides, uric acid, SBP, DBP [10], glucose [9], and several cardiovascular risk factors [30] for men and women. A possible explanation for the lack of significance of arterial blood pressure and glucose in the present study compared to the studies cited above is that the number of subjects was smaller. However, in contrast to what was observed by Ben-Noun and Laor [10], we detected a significant negative correlation between HDL cholesterol and NC. In general, our data suggest that the increase in NC may be an indicator of the worsening of blood biochemical risk factors. However, this relation must not be valid for individuals who practice resisted activities since such individuals develop the muscle mass of this region, a fact that does not necessarily represent an increase in body fat [6, 26].

We observed that NC was significantly correlated with 1-RM of the seated low row exercise. This may be explained in part by the correlation of NC with arm muscle circumference and lean mass estimated by anthropometry and by bioimpedance at the two time points. The increase in lean and muscle mass is associated with a better strength performance [26], justifying these observations. NC was also correlated with REE at both time points, with REE in turn being associated with muscle development [35]. ΔNC also showed a good association with ΔREE, suggesting that NC reduction might also reflect a reduction of REE. To our knowledge, we were the first to compare these variables. However, the common variance (r^2) for the two comparisons was low. The development of the first portion of the trapezius muscle may possibly influence NC and this muscle group is related to performance of movements that involve adduction of the scapulae such as seated low row exercise. Also, there was no correlation between NC and the bench press and leg press exercises. A possible explanation is that the muscle groups involved in these exercises have no anatomical influence on the neck. The calculations used to estimate body fat percentage and the main body indices (BMI, WHR, circumference sum) showed good correspondence, supporting the idea of the consistency of these measurements and of NC to estimate excess weight and fat in these women. In addition, both arm fat and corrected arm fat areas were significantly correlated with the body fat percentages estimated by bioimpedance and by anthropometry, respectively.

An increase in these measurements is related to subcutaneous and visceral fat and to cardiovascular risk factors [29] and the combination of these variables can be useful for the evaluation of the obesity severity and evolution of nutritional status [19].

In conclusion, regular physical activity and dietary reeducation improved body composition, biochemical risk factors and performance of these obese women within a short period of time. The neck circumference, in particular, has as positive correlation with coronary risk factors. The results also suggest that NC could be also a good predictor of body fat excess. Therefore, anthropometric body fat and neck circumference, as a whole, should be adequate to evaluate and follow obese women in a weight reduction program. Possibly, the NC could be used in conjunction with BMI to assess body fat and health impairments. Future studies with a larger sample and spectrum of BMI should be doing regarding this topic.

Table 3. Relation of neck circumference (NC) to metabolic variables and physical tests

Variables	Subjects	NC (cm) at T1 or T2		
	N	r	r^2 or IC	*P*
Resting energy expenditure (kcal/d) T1	28	0.60	0.36	0.0008*
Resting energy expenditure (kcal/d) T2	16	0.56	0.31	0.0251*
Δ Resting energy expenditure (kcal/d)	16	0.59	0.35	0.0160*
Uric acid T1 (mg/dL)†	48	0.51	0.26 a 0.69	0.0002*
Total cholesterol (TC) (mg/dL) T1	48	0.25	0.063	0.0858¶
HDL-Cholesterol (mg/dL) T1	48	-0.35	0.12	0.0139*
LDL-Cholesterol (mg/dL) T1	48	0.33	0.11	0.0224*
TC/HDL T1	48	0.47	0.22	0.0007*
Triglycerides (mg/dL) T1	48	0.25	0.06	0.0826¶
Glucose (mg/dL) T1	46	0.05	0.00	0.7227¶
Systolic blood pressure (mmHg) T1†	49	0.20	-0.09 a 0.46	0.1775¶
Diastolic blood pressure (mmHg) T1†	49	0.13	-0.16 a 0.40	0.3715¶
1-RM seated low row (kg) T1	42	0.49	0.24	0.0009*
1-RM bench press (kg) T1	42	0.22	0.04	0.1607¶
1-RM leg press (kg) T1	42	0.10	0.01	0.5465¶

Statistical analysis: Most variables presented Gaussian distribution and therefore Pearson linear correlation was used; † Spearman correlation. *Significant; ¶Nonsignificant. Δ: variation (T2-T1) of the variables in question. 1-RM: 1-repetition maximum tests.

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