Comparison of two different resistance training intensities on metabolic syndrome risk factors in obese women

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ABSTRACT
The prevalence of obesity and metabolic syndrome has been increasing worldwide. An effective solution to manage and prevent these syndromes is essential. Evidence shows that one of the single most important lifestyle changes for the prevention of many chronic diseases is exercise training. Previous studies have compared different aerobic training intensities in people with metabolic syndrome, but little is known about the effect of different resistance training intensities. The purpose of this study was to investigate the effects of eight weeks resistance training with two different intensities (50% and 75% of 1RM) on metabolic syndrome risk factors in obese women. Thirty middle-aged obese women were randomly divided into three groups: control group, low intensity group (50% of 1RM) and moderate intensity group (75% of 1RM). Exercise groups followed a supervised training program consisting of training 3 times/wk for 8 wk. The low intensity group performed 3 sets of 20 repetitions at an intensity corresponding to 50% of 1RM, with a 60-second rest period between sets, and the moderate intensity group performed 3 sets of 10 repetitions at an intensity corresponding to 75% of 1RM, with a 90-second rest period between sets. The following variables were evaluated before and after the intervention: body mass; waist circumference; blood pressure; fasting blood glucose; HDL-C and triglycerides. Eight weeks resistance training with 50% or 75% of 1RM significantly reduced body mass (-2.96%; -3.6%), waist circumference (-2.04%; -2.86%) and serum triglyceride (-4.95%; -5.93%). There were no significant differences between low and moderate intensity group. However, the results indicated that eight weeks resistance training with 50% or 75% of 1RM had no significant alteration in HDL-C, systolic blood pressure and fasting blood glucose. It seems that, resistance training program reduce some of the metabolic syndrome risk factors in obese women and there is no difference between mild and moderate intensity.

KEY WORDS: Resistance training, Metabolic syndrome, Obesity, Women.
INTRODUCTION
The prevalence of Metabolic Syndrome (MetS) has been increasing worldwide, mainly in developing countries [1]. The prevalence of metabolic syndrome has been estimated to be more than 20% of the global adult population [2]. Metabolic syndrome is defined as a cluster of at least three out of five clinical risk factors: insulin resistance, abdominal (visceral) obesity, low serum high-density lipoprotein (HDL), elevated serum triglycerides and hypertension [2]. Furthermore, various epidemiologic studies have shown powerful associations between these risk factors and the development of other chronic diseases problems such as cardiovascular disease (CVD) [3], diabetes [4], or even premature mortality [5]. Thus, effective and affordable strategies to combat the MetS would be of great individual and social importance.

Sedentary behavior which includes activities such as sitting, lying down, watching television, and other forms of screen based fun are positively associated with an increased risk of CVD mortality, type 2 diabetes [6] and MetS [7]. Evidence shows that one of the single most important lifestyle changes for the prevention of many chronic diseases is exercise training [2]. Despite the general agreement that moderate-intensity aerobic activity such as bicycling and walking maintain health and prevent the development of MetS [8], there is controversial information regarding the effects of resistance training (RT) on the reduction of risk factors and MetS-related phenotypes, particularly, in women [9]. Resistance training also known as strength or weight training, has become one of the most popular forms of exercise for enhancing an individual’s physical fitness [10]. Previous studies [11, 12] have compared different aerobic training intensities in people with metabolic syndrome, but little is known about the effect of different resistance training intensities. Research in this area has often focused on various combinations of intensities and repetitions to optimize these specific adaptations. The optimal intensity or repetitions of resistance training necessary for significant alterations in risk factors of metabolic syndrome is unknown and the results of previous studies are controversial [13]. Overall, it is unclear whether there is a certain resistance training protocol that is best designed to induce effective improvements in risk factors for the metabolic syndrome.

Balducci et al. [14], demonstrated that low intensity (50%1 RM) resistance training had a greater improvement in HDL-C, while other studies of high intensities (70–80%1 RM) revealed no improvements or even diminished HDL-C levels [15, 16]. Furthermore, improvements in HbA1c were observed following low intensity at 50%1 RM, moderate intensity at 60–70%1RM [14, 17]. However, Stensvoldet et al. [18] found no significant effects of resistance training on risk factors of MetS. In addition to, Tibana et al. [9], suggested eight weeks of whole body resistance training program with 8–12 repetitions maximum (~75% 1RM) promotes an increase on muscle thickness and strength, with no significant effects on risk factors of MetS in overweight/obese women. The conflicting data reinforce the necessity of more studies investigating the effects of different resistance training intensities on the risk factors of MetS. Therefore, the purpose of the present study was to examine the effects of eight weeks resistance training with two different intensities (50% and 75% of 1RM) on metabolic syndrome risk factors in obese women.

METHODS
Subjects
Thirty obese female subjects (35–45 years) who did not have resistance exercise or weight training experience in the past, volunteered to participate in this study. Metabolic syndrome was defined according to the International Diabetes Federation and comprised central obesity, elevated systolic blood pressure (SBP) and diastolic blood pressure (DBP), high plasma glucose and triglyceride levels, and low levels of HDL-cholesterol (HDL-C) [18]. Individuals completed a thorough physical examination, including a medical history, blood pressure assessment and anthropometric evaluation prior to participation in the experimental protocols. As inclusion criteria, (a) the only participants included were those aged between 30–50 y, (b) classified as obese by BMI measurement according to the World Health Organization (BMI ≥30), (c) free from cardiac or orthopedic dysfunction and those without consistent resistance training for the past six months before the study period. Subjects were informed of the experimental risks and signed an informed consent document before the investigation. Subjects were randomly divided into three groups: control group (n = 10), low intensity group (n = 10) and moderate intensity group (n = 10).

**Study design**

The present study was designed to investigate the effects of eight weeks resistance training with two different intensities (50% and 75% of 1RM) on metabolic syndrome risk factors in obese women. All testing and training sessions were conducted between 10:00–12:00 am. Dietary information of participants was obtained by food record on three nonconsecutive days (two week days and one weekend day). Subjects were advised to maintain their normal daily eating habits throughout the study.

Volunteers completed one week of familiarization prior to testing (3 sessions/week), where they were advised regarding the execution of proper technique. In the last familiarization session, subjects’ 1RM strength for each exercise was determined according to the Brzycki formula “predicted 1RM = weight lifted/[1.0278-(0.0278 × the number of repetitions performed)]” [10]. The resistance training protocol began two days after 1RM testing and was performed on three nonconsecutive days of the week, comprising eight exercises. Metabolic syndrome risk factors were evaluated before familiarization prior and 48 hours after the last session of resistance training.

**Resistance training program**

In this study circuit resistance training was used for the purpose of this study [19, 20]. The resistance training session started with a warm-up period using commercial resistance training equipment. Exercise groups followed a supervised resistance training program consisting of training 3 times/wk for 8 wk. All training sessions were carefully supervised by an exercise physiologist. Participants were required to complete at least 80% of the exercise sessions. The control group did not complete the training protocol. For the duration of the training protocol, they were instructed to maintain their normal daily activities. Whole body resistance exercise training protocol involved upper and lower body exercises (chest press, shoulder press, lat pull down, machine elbow flexion, abdominal crunches, leg extension, leg curl and seated calf raise) [19, 20]. The warm-up procedure consisted of 5 minute running and 5 minute light stretching exercises in regard to the muscles involved in the main experiment. During the first and second week of training, the resistance was set at ~ 50% of each individual’s 1RM. After the second week, target training load for each subject for each exercise was determined according to their experimental training group. The low intensity group performed 3 sets of 20 repetitions at an intensity
corresponding to 50% of 1RM, with a 60-second rest period between sets, and the moderate intensity group performed 3 sets of 10 repetitions at an intensity corresponding to 75% of 1RM, with a 90-second rest period between sets (table 1) [19, 20]. The loads were updated when necessary to keep the number of repetitions within the same range of RM and to provide a progressive overload. Additionally, correct breathing patterns were instructed to avoid Valsalva maneuver.

### Anthropic and blood pressure measurements

Body weight and height were measured using a standard scale and set to the nearest 0.1 kg and cm, respectively. Body mass index (BMI; in kg/m²) was determined using body weight and height. Waist circumference (over the navel) was measured to the nearest 0.1 cm using a plastic tape measure. Systolic (SBP), diastolic (DBP) were measured with an oscillometric device (Microlife, Switzerland). The average of the last two of three measurements was used to report the mean SBP and DBP. Variables were evaluated before familiarization prior and 48 hours after the last session of resistance training.

### Biochemical parameters

After an overnight fast, participants arrived at the laboratory between 08:00–10:00 am, for blood withdrawal from the antecubital vein. Blood sample was collected before familiarization prior and 48 hours after the last session of resistance training. The blood samples were sent to hematology laboratory to be analyzed using standard laboratory procedures. Plasmatic triglycerides, glucose and HDL-C were analyzed using Siemens Advia 2400 automated analyzer (USA).

### Statistical analysis

Data were expressed as means (± SD). The normal distribution of the data was checked using Shapiro-Wilk normality test. The pre and post-intervention variables were compared by using paired Student’s t-test (within-group differences). Then, one-way ANOVA was used to compare the post-test and Δ (posttest-pretest) values between groups (between-group differences). All statistical analyses were performed using the SPSS statistical software package (SPSS version 22.0 for Windows, SPSS Inc., Chicago, IL, USA). The significance level was set at p<0.05.

### STATISTICAL RESULTS

Subjects’ general characteristics are presented in Table 2. At the beginning of the study, there were no significant differences between three groups in general characteristics and metabolic syndrome risk factors (P>0.05). The results of this study indicated that body weight, waist circumference and serum triglyceride significantly decreased after eight weeks of resistance training in the low intensity group and moderate intensity group (P≤0.05). Low and moderate intensity groups had 2.96% and 3.6% reduction in body weight; 2.04% and 2.86% reduction in waist circumference and 4.95% and 5.93% reduction in triglyceride, respectively (figure 1, 5). However, the results indicated that there was no significant alteration between pre-test and post-test of HDL-C, systolic blood pressure and fasting blood glucose levels in all groups (P>0.05; figure 2, 3, 4). The control group had no significant alteration in all parameters (P>0.05). In addition, there were no
significant differences between low and moderate intensity group in post-test and Δ (posttest-pretest) values of metabolic syndrome risk factors (P>0.05).
DISCUSSION

The aim of the present study was to analyze the effects of eight weeks resistance training with two different intensities (50% and 75% of 1RM) on metabolic syndrome risk factors in obese women. The main findings of the present study were that eight weeks resistance training (with 50% or 75% of 1RM) significantly reduced body weight, waist circumference and serum
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There were no significant differences between low and moderate intensity group. However, the results indicated that eight weeks resistance training with 50% or 75% of 1RM had no significant alteration in HDL-C, systolic blood pressure and fasting blood glucose.

Resistance training is recommended by the American Heart Association, the American College of Sports Medicine and the American Diabetes Association as an effective tool to prevent and treat metabolic diseases [9]. These recommendations are based on evidence showing that resistance training promotes increased muscle mass, glucose transporter (GLUT-4), protein kinase B and glycogen synthase in obese and diabetic individuals [21]. However, fully understanding of the mechanisms responsible for the improvements in metabolic syndrome risk factors remains to be determined.

The results of the present study revealed that low and moderate intensity groups had 2.96% and 3.6% reduction in body weight and 2.04% and 2.86% reduction in waist circumference, respectively. Recently, there has been an increased focus on the accumulation of excess fat in the abdominal region, and it has been proposed that waist circumference is a better indicator of the risk of developing cardiovascular diseases than either BMI or the waist-to-hip ratio [18]. Increased waist circumference is considered the main inclusion criteria for metabolic syndrome (according to the International Diabetes Federation), and in the present study, the resistance training with 50% or 75% of 1RM had a significant reduction of waist circumference. The results of this study are aligned with other previous study which also showed resistance training resulting in a reduction in waist circumference and body weight [18, 22]. However, there were no significant differences between low and moderate intensity group. It seems that, volume of training plays a key role in relation to the effects of resistance training on weight loss and waist circumference. Adequate volume of training promotes further decrement of fat mass (FM) and FFM at the particular group of muscles involved during training, which is known as localized fat loss due to increased muscle activation [23].

In the present study, resistance training with 50% or 75% of 1RM had no significant alteration in systolic blood pressure. This result is in disagreement with those of Cornelissen and Fagard [24], and Moraes et al. [25] who reported a decrease in blood pressure after resistance training. The studies that showed hypotensive effects of resistance training included women who started with initial systolic blood pressure values of 125 mmHg to 150 mmHg which were much higher than the values in this study. In addition to, the results of the present study demonstrate a favorable response of serum triglyceride to resistance training. In this regards, low and moderate intensity groups had 4.95% and 5.93% reduction in triglyceride, respectively. However, there were no significant differences between two different intensity. Nevertheless, resistance training with 50% or 75% of 1RM had no significant alteration in HDL-C. This result is in disagreement with studies of Fahlman et al. [26] and Balducci et al [14]. The duration of the training period was 10 weeks in the first study and 16 weeks in the second study. According to Durstine et al [27], almost no change in HDL-C related to exercise occurs when the exercise training program is shorter than 12 wk, but when training programs last longer than 12 wk, increased HDL-C levels are more likely to be reported. In addition to, meta-analytic data showed that isolated exercise programs without caloric restriction induced limited improvements on cardiovascular risk factors. Shaw et al. [28] evaluated 43 studies...
including 3476 participants and found that
exercise without caloric restriction control is
associated with a lower decrease of body mass,
blood pressure and blood glucose as compared
with exercise associated with dietary restriction.
Orozco et al. [29] compared the effects of
isolated diet and diet + aerobic and resistance
training. Results showed that diabetes risk was
lower in the combined group. Additionally,
individuals submitted to exercise training + diet
presented a decrease of blood pressure and
anthropometric indexes of obesity, which was
not observed for the group of isolated exercise.
In the present study, subjects were advised to
maintain their normal daily eating habits
throughout the study. Our findings indicate that
resistance training with 50% or 75% of 1RM had
no significant alteration in fasting blood glucose.
Tibana et al. [9] reported that eight weeks of
resistance training had no significant effect on
blood glucose, HDL-C, insulin and glycated
hemoglobin. In an apparent conflict with our and
above study, Tomeleri et al. [30] reported that
fasting blood glucose showed significant
decreased after 12 weeks of resistance training.
The study of Tomeleri that showed reducing
effect of resistance training on blood glucose
included older women who started with initial
fasting blood glucose values of 100 mg/dL to
116 mg/dL which were much higher than the
values in this study. In the other word, the
subjects of present study had normal values of
fasting blood glucose at the beginning of the
study.

The present study has some limitations that
should be considered, such as the limited time of
the intervention (only eight weeks), the reduced
number of participants and lack of more accurate
measures to evaluate body composition. In
addition to, metabolic syndrome is characterized
by a cluster of risk factors, but not all subjects
have all risk factors. The number of subjects in
our study was small; therefore, larger
multicenter studies are encouraged to reinforce
our findings. The variation in age can explain the
large variation in some of the results. On the
other, it was not possible to objectively monitor
physical activity levels outside the intervention
protocol in free living. However, the subjects
were asked to maintain their usual daily living
activities throughout the investigation period to
minimize lifestyle interferences. In overall, this
study demonstrates that eight weeks resistance
training with low or moderate intensities (50%
or 75% of 1RM) can be used to improve some of
the metabolic syndrome risk factors in the obese
women, namely reducing body weight, waist
circumference and serum triglyceride. However,
there were no significant differences between
low and moderate intensity training. The
physiological mechanisms underlying
improvements in the metabolic syndrome
risk factors following resistance training have
not been fully elucidated and remain complex.
In addition to, it is unclear whether resistance
training with 50% or 75% of 1RM has a
beneficial effect on HDL-C, systolic blood
pressure and fasting blood glucose – the present
results suggest that it does not. These
preliminary findings indicate that whole body
resistance training, without any aerobic training
and supplementation, regularly performed 3
times a week for 8 weeks, has protective effects
on body weight, waist circumference and serum
triglyceride in previously untrained obese
women. Moreover, these positive effects seem to
be independent of the training intensity.
Therefore, further studies are necessary to better
understand the effects of resistance training with
different intensities on metabolic syndrome risk
factors in women.

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REFERENCES


