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Effects of Caloric Restriction Associated with Low-Impact Aerobics and Strength Training Exercises on Body Compositions and Metabolic Syndrome Components among Obese students

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ABSTRACT

Diet and physical activity are the most commonly recommended strategies for preventing and treating obesity and metabolic conditions. This study aims to examine the effectiveness of a weight reduction intervention based on caloric restriction, low-impact aerobics (LIA), and a resistance-training program in improving patients' anthropometric and biochemical indicators and the incidence of metabolic syndrome (MetS) among youth with obesity. In all, 64 participants were introduced to an enhanced lifestyle counseling and dieting program (the diet group, or DG) or to enhanced lifestyle counseling, dieting, and a supervised physical training program (the diet and training group, or DTG). Individuals diagnosed with MetS were analyzed in this study (DG: N = 09; DTG: N = 14). Before and after the intervention, the participants' anthropometric measures and cardiovascular disease (CVD) risk factors were assessed. Following the interventions, significant improvements were noted in all anthropometric variables among all participants ($p \leq 0.001$ for all). Significant differences were noted between groups in terms of body weight ($p \leq 0.05$), waist circumference (WC; $p \leq 0.01$), body mass index (BMI; $p \leq 0.05$), fat percentage (F%; $p \leq 0.05$), and waist-to-hip ratio (WHR; $p \leq 0.05$). All MetS components also improved in both groups, and the most significant improvements were observed among the training group in terms of fasting blood glucose (FBG) level ($p \leq 0.05$), triglyceride (TG) level ($p \leq 0.001$), overall cholesterol (OC; $p \leq 0.01$), low-density lipoprotein cholesterol (LDL-c; $p \leq 0.05$), and very low-density lipoprotein cholesterol (VLDL-c; $p \leq 0.001$).

Conclusion: A minor daily caloric restriction (of approximately 500 kcal) program could be an effective tool in combating MetS. Further, the introduction of three weekly aerobic and resistance-training sessions in a gymnasium to the caloric restriction program may deliver better outcomes, mainly in terms of reductions in body weight, WC, FBG level, TG level, OC, LDL-c, and VLDL-c.

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Materials and Methods

Subjects

In all, 299 sedentary individuals aged 19-24 years were evaluated for enrollment in the study. The inclusion criteria were a sedentary lifestyle (walking less than 1.5 miles daily), a BMI between 30 and 40 $kg.m^{-2}$, and a lack of any contraindications regarding physical exercises according to the American College of Sports Medicine guidelines (ACSM, 2009). Participants who met the eligibility criteria and agreed to participate (N = 64) were screened for MetS, and subjects diagnosed with this disease (N = 23) were randomly introduced to an enhanced lifestyle counseling and dieting program (the dieting group, or DG: N = 9) or to an enhanced lifestyle counseling, dieting, and supervised physical training program (the diet and training group, or DTG: N = 14) (Figure 1). All participants were informed about the possible risks and benefits of the study and signed consent forms before it began (Figure 1).

Study design and ethics.

This study was conducted between October 2016 and March 2017 in compliance with the U.S. Department of Health and Human Services recommendations and reports according to the International Compilation of Human Research Standards (OHRP, 2016). Ethical approval was obtained from the Ethical Committee of the Deanship of Scientific Research of King Faisal University (project number 186020, Saudi Arabia).

The study spanned 16 weeks, the first four of which were dedicated to establishing changes in the participants' dietary behaviors (the adaptation phase). Following this stage, the participants were randomly distributed into two groups. The first group, the DG, continued with the dieting program without any further changes, while supervised aerobic and resistance-training sessions were added to the next 12 weeks of the program of the second

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group, the DTG. In addition, all subjects were scheduled for monthly lifestyle counseling sessions conducted by lifestyle coaches and aimed to motivate the participants and make adjustments to their programs if necessary. At the beginning and the end of these interventions, anthropometric measures and CVD risk factors were assessed.

Outcomes and Assessments

1. **Anthropometric Measurements**

Height, weight, WC, BMI, F%, and waist-to-hip ratio (WHR) were determined by bioelectrical impedance analysis using a body composition analyzer (ACCUNIQ BC360, SELVAS Healthcare, Inc., Republic of Korea).

1. **Blood sample analysis**

Following a fast of 12 hours or more and a 10-minute relaxation period in the laboratory, participant blood pressures (BPs) were measured using a wireless BP monitor (iHealth Labs Inc., Canada). In addition, approximately 10 ml of venous blood were collected from each patient in anticoagulant-free tubes. Droplets of blood were used to measure patients' FBG levels using a blood glucose monitor (OneTouch Verio® meter, LifeScan, Inc., Milpitas, Canada), and the remaining blood was centrifuged at 3000 rpm for 15 min at 4°C. The serum was then withdrawn and stored at -80°C until analysis. All measurements were performed at the Laboratory of KFU Medical Center. Lipid profiles and their extensions, including OC, TG level, HDL-c, LDL-c, and the very low-density lipoprotein-cholesterol (VLDL-c), were assessed using VITROS commercial kits (Ortho-Clinical Diagnostics, California, USA).

Interventions

1. **Enhanced Lifestyle Counseling**

A description of enhanced lifestyle counseling is given in Wadden et al. (2011). In the present study, lifestyle coaches supervised all counseling sessions to reinforce motivation and support the weight loss program by reinforcing the patient's desire to lose weight, helping them cultivate an identity as a successful weight loser, eliciting autonomous motivation from them, and creating an array of non-food.

1. **Dietary Protocol**

A dietician established a balanced and personalized dietary restriction program for each subject based on an initial dietary behavior assessment (the amounts of food and fluid consumed by each subject for a week and the relevant timestamps were recorded). Each individual’s diet was designed according to their dietary habits and other selected foods with low glycemic indices, which were mainly fruits, vegetables, and whole grains. Fast foods, sugar-sweetened drinks, energy drinks, French fries, potato chips, cake, donuts, and sweets were to be avoided. Subjects' targeted daily caloric intake deficit was approximately 500 kcal/day, and diets were composed of approximately 15-20% proteins and 25-30% lipids, with carbohydrates representing the remainder of the caloric intake (Varady, 2011). A software for food coaching was used to calculate participants' food intake and composition (S.C.D.A. Nutrisoft, Le Hallier 37390 Cerelles, France).

1. **Physical activity**

The program involved three sessions per week of LIA and resistance exercises conducted on machines. Each session involved a 5- to 10-minute warmup, an exercise session, and a 5- to 10-minute cooldown. Warmups involved walking and stretching exercises to engage the body's major muscles, and the exercise session load (intensity and duration) increased according to the American College of Sports Medicine guidelines (ACSM, 2009). LIA exercises lasted between 30 and 40 min and involved moving in a continuous rhythm (without any jumping) to maintain a fixed heart rate. Muscle-strengthening exercises (abdominal curls, sit-ups, leg extensions, leg flexions, lateral pulldowns, bench presses, shoulder presses, triceps

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extensions, and biceps curls) were performed on machines in 2-3 sets of 8-12 repetitions each with a 1-min rest between sets and a 3-min rest between exercises. Professional trainers supervised all training sessions, and a polarity analyzer (Polar Electro Oy, Finland) was used to maintain fixed heart rates throughout the session.

Statistical Analysis

Data distributions were checked for normality by the Kolmogorov-Smirnov test. All results were presented as mean ± standard deviation (SD) and compared using Student's t-tests. A Pearson's correlation coefficient was used to assess the relationships between the parameters. For all analyses, the Statistical Package for the Social Sciences (SPSS 16.0) was used, and statistical significance was set at $p < 0.05$.

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