



Original Article

Effect of a 12-week complex training on the body composition and cardiorespiratory system of female college students

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Abstract. [Purpose] The aim of this study was to examine the effects of a complex exercise program on the body composition and cardiorespiratory system of female college students. [Subjects and Methods] This study included 20 female college students who had not participated in any particular sports in the last 3 months. The complex exercise program consisted of two parts, aerobic exercise and weight training. First, aerobic exercise was implemented (30 min 5 times a week for 12 weeks) according to the participants' exercise tolerance. Second, weight training was implemented (40 min 5 times a week for 12 weeks) with 60% of 1 repetition maximum (RM). [Results] The t-test results showed significant differences in body composition between the before and after the complex exercise program. The subjects' body weights and body fat percentages were decreased, and their skeletal muscle masses were increased. Increased levels of maximal oxygen uptake (VO_{2max}), maximal expiratory volume (VE_{max}), and maximal heart rate (HR_{max}) were also observed. [Conclusion] In conclusion, the 12-week complex exercise program, including aerobic and weight training, had positive effects on the body composition and cardiorespiratory system of the female college students.

Key words: Complex training, Body composition, Cardiorespiratory system

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INTRODUCTION

The incidence of various adult diseases in young adults has increased because of the decrease in physical activity as students aged between 18 and 24 years move from high school to college^{1, 2)}. In general, the physical activity levels of females tend to be lower than that of males³⁾. Numerous factors contribute to adult diseases, but obesity caused by reduced physical activity is regarded as one of the most important factors of the development of adult diseases^{4, 5)}. The 5 negative effects of obesity—disfigurement, discomfort, disability, disease, and death—are also referred to as the 5-Ds⁴⁾. Therefore, proper management of body weight through regular physical activity that balances the body composition, including body fat and skeletal muscle, is required to prevent various adult diseases and maintain psychological well-being³⁻⁵⁾. In particular, complex training is considered an effective exercise program for improving both body composition and the cardiorespiratory system⁶⁻⁸⁾. Complex training is defined as a “complex of exercises for the development of reactive ability which is fulfilled in a background of heightened excitability of the central nervous system, brought about by preliminary fulfillment of exercise requiring great power”⁹⁾. Despite its growing popularity¹⁰⁾, the study of complex training is relatively limited. Therefore, the aim of this study was to examine the effects of complex training on body composition and the cardiorespiratory system of female college students in an effort to provide fundamental data for establishing a training program to improve the health of young adults, particularly with respect to body composition and the cardiorespiratory system.

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SUBJECTS AND METHODS

This study included 20 female college students from D university in D city who had not participated in any particular sports in the last 3 months (Table 1). All the subjects were informed of the content and purpose of the experiment, and written informed consent was obtained before beginning the study. Body composition was examined, and an exercise tolerance test was performed twice, at the beginning and end of the study. For estimation of body composition, weight (kg), body fat percentage (%), and skeletal muscle mass (kg) were measured by using bioelectrical impedance analysis equipment (Salus, Bio-Space, Korea). The subjects were instructed to fast for 4 hours, rest for 13 hours without exercise, and urinate (30 min before) prior to the measurement. Exercise tolerance was estimated by using the Bruce Protocol with an initial speed of 1.7 mph, which was increased by 0.8 mph every 3 min, and gradient of 10%, which was increased by 2% every 3 min. Maximum heart rate (HR_{max}), maximum oxygen uptake (VO_{2max}), and maximum ventilation (VE_{max}) were estimated by using a breath-by-breath respiration analysis assembly with a gas analyzer (Quark b2, Italy) in the peak mode. Blood pressure was measured every 2 min by using an automated blood pressure monitor (Tango, Suntech, USA). Electrocardiography was performed by using the CH 2000 system (Cambridge Heart, MA, USA) during exercise. The complex exercise program consisted of two parts, aerobic exercise and weight training. First, aerobic exercise (walking and running) was implemented (30 min 5 times a week for 12 weeks) according to the participants' exercise tolerance. Heart rate was recorded throughout the exercise by using a portable recordable HR monitor (Polar Electro, Technogym, Finland). The exercise intensity was increased from 50% HR_{max} in the first week of training to 70% HR_{max} at the end of training. Second, weight training was implemented (40 min 5 times a week for 12 weeks) with 60% of 1 repetition maximum (RM), calculated by using Kuramoto and Payne's formula. Weight training included lower back extension, shoulder press, rotary torso, abdominal, chest press, leg curl, leg extension, and leg press. SPSS 20.0 was used for data processing. Differences between before and after the exercise program (12-week) were calculated by using a t-test. A p value of <0.05 was considered statistically significant. All the experiments were thoroughly reviewed and approved by the institutional review board of Daegu University.

RESULTS

The t-test results showed significant differences in body composition and cardiorespiratory system between before and after the complex exercise program (Table 2). In detail, the subjects' body weight decreased ($p<0.01$) from 55.4 ± 1.3 kg to 49.5 ± 1.1 kg, body fat percentage decreased ($p<0.01$) from $29.6\% \pm 1.2\%$ to $24.1\% \pm 1.3\%$, and skeletal muscle mass increased ($p<0.05$) from 20.5 ± 1.6 kg to 23.9 ± 0.7 kg. VO_{2max} increased ($p<0.01$) from 28.3 ± 1.4 ml/(kg·min) to 33.8 ± 0.4 ml/(kg·min), VE_{max} increased ($p<0.05$) from 25.6 ± 0.5 l/min to 29.6 ± 0.4 l/min, and HR_{max} increased ($p<0.05$) from 187.2 ± 2.3 beats/min to 193.5 ± 2.5 beats/min.

DISCUSSION

In today's society, strong emphasis is placed on physical appearance. In particular, females tend to focus more on body shape, even resorting to unverified diet plans in the hope of losing body fat and weight. Therefore, psychological and physical health problems arise as a result of stress, anxiety, depression, menstrual irregularity, and unbalance of body composition

Table 1. General characteristics of the study subjects (n=20)

Age (yrs)	Height (cm)	Weight (kg)	Body fat (%)	Skeletal muscle (kg)
20.5 ± 1.1	163.1 ± 2.3	55.4 ± 1.3	9.6 ± 1.2	20.5 ± 1.6

Data are expressed as mean \pm SD.

Table 2. Pre- and post-exercise program weight, body fat, skeletal muscle, and cardiorespiratory system

Items	Pre	Post
Weight (kg)	55.4 ± 1.3	$49.5 \pm 1.1^{**}$
Body fat (%)	29.6 ± 1.2	$24.1 \pm 1.3^{**}$
Skeletal muscle (kg)	20.5 ± 1.6	$23.9 \pm 0.7^*$
VO_{2max} (mL/[kg·min])	28.3 ± 1.4	$33.8 \pm 0.4^{**}$
HR_{max} (beats/min)	187.2 ± 2.3	$193.5 \pm 2.5^*$
VE_{max} (L/min)	25.6 ± 0.5	$29.6 \pm 0.4^*$

Data are expressed as mean \pm SD. Significant differences ($^{**}p<0.01$, $^*p<0.05$) between before and after the complex exercise training program are indicated.

by the weakening of muscle functions, neuroregulation, and immune system^{11–16}. For this reason, prestigious sport and medical societies, including the American College of Sports Medicine¹⁷ and the Korean Society for the Study of Obesity (KSSO)¹⁸, suggest regular exercise (30 to 60 min, 3 to 5 times a week) with moderate intensity (50–60% of VO_{2max}) to balance body composition, lose body fat while developing skeletal muscle, and maintain psychological health. In this study, a 12-week complex exercise program that included aerobic and weight training significantly improved the body composition and cardiorespiratory system of female college students. This result can be explained as follows: loss of body fat increases the lipolysis rate and the amount of fatty acid in the muscle, activating the β -oxidation process¹⁹, and increased skeletal muscle mass and basal metabolic rate by weight training are thought to burn more body fat^{4, 20}. In terms of improvement in the cardiorespiratory system, the 12-week complex exercise program increased VO_{2max} and VE_{max} at the cellular level^{21–23}. Thus, circular breathing capacity, oxygen transport ability, and capillary density would also be improved^{21–23}. The results of this study are consistent with those of previous studies that suggested a positive effect of aerobic and weight training on body composition and the cardiorespiratory system^{4, 20–22}.

In conclusion, although a regular complex exercise program consisting of aerobic and weight training cannot change the structure of the body and the respiratory system, 12 weeks of regular participation in the complex exercise program can maintain or improve the respiratory circulation function and strengthen the overall skeletal muscle, which in turn burns body fat. Therefore, more-active development and application of this effective and practical complex exercise program are needed. Specifically, exercise programs aimed at people whose goal is to maintain their general mental and physical health should be differentiated from those that focus on improvement of athletic performance. In addition, personalized exercise programs should be developed based on gender and lifestyle.

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