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Effect of Circuit Training on Aging-related Hormones in Obese Middle-aged Women

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Due to aging, the physical fitness of middle-aged women decreases after menopause. This results in increased body fat and reduced lean body mass, both of which can lead to obesity. This phenomenon is accompanied by changes in hormone secretion in the body. The purpose of this study was to analyze the effects of circuit training on aging-related hormones in obese middle-aged women. The subjects were 20 obese middle-aged women. The subjects were divided into two groups: a circuit training group (n=10) and nonexercise control group (n=10). Growth hormone (GH), insulin-like growth factor-1 (IGF-1), estrogen, and DHEA-S were measured before and after the circuit training program. The circuit training group performed circuit training for 12 weeks, three times per week. Exercise intensity was increased gradually from 60% to 80% of heart rate reserve every 6 weeks. In the circuit training group, at the end of the 12-week training program, the IGF-1 levels were significantly increased compared to pre-exercise levels, and they were higher than those of the control group. GH levels were also significantly increased in the circuit training group, but the differences were not statistically significant. DHEA-S was significantly increased in the circuit training group, but the difference was not statistically significant. The results showed that circuit training improved aging-related hormones levels in obese middle-aged women.

Key words : DHEA-S, estrogen, GH, IGF-1, obese

Introduction

The human body has many physiological control mechanisms that contribute to the maintenance of homeostasis. However, due to aging, the physical fitness of middle-aged women decreases after menopause. This results in increased body fat and reduced lean body mass, both of which could lead to obesity. This phenomenon is accompanied by changes in hormone secretion in the body.

Aging decreases the secretion of growth hormone (GH) and insulin-like growth factor 1 (IGF-1), which could lead to metabolic disorders [12]. There are reports of increased body fat resulting from GH deficiency [24]. Changes in body composition and function from aging leads to decreased concentrations of IGF-1, and the reduction is associated with cardiovascular diseases [9].

Moreover, aging causes changes in the female endocrine system. After menopause, the concentration of estrogen decreases significantly, and the reduction is reported to increase the incidence of metabolic diseases [14].

DHEA-S, a steroid hormone secreted from the adrenal glands in its ester form [5], circulates in the blood in high concentrations during puberty but in significantly lower concentrations in older populations. Given that reduced DHEA-S levels could lead to degenerative diseases, diabetes, and atherosclerosis, it is an important index of aging [4, 27].

As such, the aging process is accompanied by various symptoms, such as decreased hormone secretion. However, increase in physical activities is known to regulate the secretion of aging-related hormones, which prevent and delay aging [7].

Previous studies reported that regular exercise stimulates the secretion of GH/IGF-1 [18, 25] while increasing the levels of estrogen [20] and DHEA-S [19].

Circuit training is a form of exercise that combines multi-

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Table 1. Participant characteristics

	EX (n=10)	CON (n=10)
Age (yrs)	43.11±2.89	42.67±2.87
Height (cm)	161.31±5.03	163.36±4.35
Weight (kg)	70.89±5.46	70.02±9.94
%Body fat (%)	34.60±2.37	33.91±3.05

joint resistance training and calisthenic workouts. Reducing the resting time between each set and each workout is an important factor in increasing and maintaining a higher heart rate and blood pressure [8].

Circuit training not only enhances muscular strength but also improves the overall cardiorespiratory function [17].

Therefore, this study aims to identify the effects of circuit training on aging-related hormones in middle-aged women, among whom the obesity rate has been recently increasing.

Materials and Methods

Participant characteristics

This study involved 20 obese middle-aged women. The subjects were divided into 2 equal groups: to ensure biologic homogeneity: the circuit training group (EX, n=10) and non-circuit training control group (CON, n=10). All subjects provided written informed consent prior to participation. and ethical approval was granted by our Institutional Human Research Committee (PNU IRB/2016_45_HR).

Body composition

Body composition was measured prior to the experiment by using Inbody X-scan plus (Jawon medical, Korea).

Circuit Training

The subjects subsequently engaged in preliminary exercise for one week to adapt to the circuiting training program application. The circuiting training consisted of 5 min warm-up, 20 min of main exercise, and 5 min cool down, for a total duration of 30 min (Table 2).

Aging related hormone

Serum estrogen concentrations were measured in duplicate by radioimmunoassay (Diagnostic Systems Laboratories, Webster, TX, USA). GH was measured using the Beckman Access Ultra sensitive human GH assay, a paramagnetic particle, chemiluminescent immuno assay (Beckman Coulter, Chaska, MN). IGF-I concentrations were measured by means of the Ray－Bio Human IGF-I ELISA KIT (Norc ross GA. USA). A monoclonal antibody specific to the appropriate human sequence of IGF-1 had been pre-coated in a 96-well microtitre plate. IGF-I was separated from binding proteins. DHEA-S was measured in serum using a commercial single antibody radioimmunoassay (RIA) for human DHEA-S (Siemen's Coat-a-Count DHEA-Sulphate RIA kit, Siemens Medical Solutions USA, Inc., Los Angeles, CA).

Data analysis

All data are presented as mean ± SD, and all statistical analyses were completed using SPSS version 23.0 for Windows (SPSS Inc., Chicago, IL, USA). All statistical tests used an alpha level set at $p<0.05$. Changes from baseline to the end of the intervention were determined using the paired t-test and the independent t-test.

Results

All the participants characteristics and percent body fat were measured before the start and at the end of the 12-week circuiting training. There were no significant differences in

Table 2 Circuit training protocol

weeks	Order		Intensity	Duration	Time
1-12	Warm-up (5 min)	Stretching			3 times/ weeks
	Main exercise (20 min/set)	· Rope-jumping · push up · Rope-jumping · abdominal curl · Rope-jumping · squat	60-70%HRR (RPE13-14)	1-5	
		· Rope-jumping · bench press · Rope-jumping · core exercise · Rope-jumping · side lunge · Rope-jumping · burpee test · Rope-jumping	70-80%HRR (RPE15-17)	6-12	
	Cool-down (5 min)	Stretching			

Table 3. Changes of aging related hormone within each group

	Group	Pre	Post	T-value
IGF-1	EX (n=10)	160.43±26.68	182.85±21.53	2.885*
	CON (n=10)	166.20±32.25	164.43±40.05	0.341
	T-value			2.596*
GH	EX (n=10)	2.60±2.06	3.65±3.06	2.510*
	CON (n=10)	2.80±1.85	2.34±1.55	1.113
	T-value			1.470
DHEA-S	EX (n=10)	130.64±31.23	143.93±28.00	2.583*
	CON (n=10)	126.14±19.59	125.68±28.21	0.058
	T-value			1.591
Estrogen	EX (n=10)	471.06±180.38	510.63±142.37	1.483
	CON (n=10)	420.29±150.08	447.61±208.73	0.710
	T-value			0.727

Values are M±SD * $p<0.05$

baseline demographic characteristics between the study groups. Tables 3 show that the baseline values between the two groups were comparable for aging related hormone activity. Circuiting training resulted IGF-1 in the circuiting training group had significantly increased ($p<0.05$) and circuiting training group was higher than that of control group. GH, DHEA-S in the circuiting training group significantly increased ($p<0.05$).

Discussion

Synthesis and secretion of GH increase after the prenatal stage of life and decrease with age [22]. Exercise stimulates the natural secretion of GH [13], and IGF-1, which is regulated by GH, is known to contribute to GH-mediated growth stimulation [15].

After endurance exercise, the GH level increased significantly in obese women [6]. Similarly, 12 weeks of circuit training also led to a significant increase in GH levels in middle-aged obese women [2]. From this result, it can be concluded that regular physical activity activates GH secretion in subjects with obesity [16].

Increased physical activity improves insulin function and consequently reduces insulin resistance. Reduced insulin levels activate and significantly increase IGF-1 [10], and high-impact exercise leads to greater increases in IGF-1 than low-impact workouts do [28]. In this study, the levels of GH and IGF-1 were higher ($p<0.05$) in the circuit-training group than in the control group. Appropriate exercise increases GH secretion, which leads to higher IGF-1 concentrations [1].

Circuit training causes growth and hypertrophy of skeletal muscles, increasing the use of fat as the energy source. Hence, circuit training is an effective way of preventing obesity in middle-aged obese women.

The aging process in women is closely related to changes in the endocrine system, especially the reduced production of estrogen in the ovaries [14]. Circuit training increases the secretion of epinephrine and norepinephrine hormones, which stimulate the breakdown of fat in muscles and increase the blood flow to skeletal muscles. This results in the stimulation of adipose tissue degradation, while also stimulating the growth and development of female genital organs [26].

Increased central adiposity in middle age women is mainly due to the reduced estrogen which is also associated with increased visceral fat accumulation [11].

Stimulation of the central nervous system from regular physical activity is reported to stimulate estrogen secretion [3]. However, in this study, estrogen levels did not change significantly after circuit training. There seems to have been no personal variation in the duration and types of exercise conducted by the participants, and thus further study is required to confirm whether this finding can be replicated.

Aging causes changes in the endocrine system, especially in DHEA-S levels, which are highly correlated with chronic degenerative diseases [26]. Thus, DHEA-S is an important index of aging. DHEA-S is produced in the adrenal cortex and is the most common steroid hormone in the blood that decreases significantly with age [21].

DHEA, which is a precursor to female and male hormones, is associated with muscle mass in older individuals, and the hormone concentration increases with enhanced physical fitness [23].

In this study, DHEA increased significantly (p<0.05) after circuit training. The positive change in DHEA concentration resulting from changes in muscle mass due to circuit training implies that DHEA has close correlation with exercise intensity and type.

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초록 : 서킷 트레이닝 비만 중년 여성의 노화 관련 호르몬에 미치는 영향

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노화 과정에 따라 중년 여성들은 폐경 이후 체력이 저하되기 시작하면서 체지방 증가와 제지방량의 감소로 비만으로 이어지기 쉽고, 이러한 현상은 체내 호르몬의 분비의 변화와 함께 발생된다. 본 연구는 서킷 트레이닝이 비만 중년 여성의 노화 관련 호르몬에 미치는 영향을 구명하기 위해 실시하였다. 대상자 체지방률 30% 이상인 비만 중년 여성 운동군 10명, 대조군 10명 총 20명을 실시하였다. 운동 시간은 준비운동 5분, 본 운동 20분, 정리운동 5분으로 총 30분 주 3회 실시하였으며, 운동 강도는 운동자각도를 이용하여 13~17(약간 힘들다-매우 힘들다)수준으로 실시하였고, 또한 POLAR 심박수 변화량을 측정하여 1~6주는 60~70%HRR (Heart rate reserve), 7~12주는 70~80%HRR로 설정하였다. IGF-1은 운동군이 유의하게 증가하였으며, GH는 운동군이 유의하게 증가하였고, DHEA-S는 운동군이 유의하게 증가하였다. 이상의 결과 서킷 트레이닝이 비만 중년 여성의 노화 관련 호르몬에 긍정적인 영향을 준 것으로 사료된다.