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The Effect of Aerobic Exercise and CWT on Cardiorespiratory Function and Body Composition For Female Workers

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Abstract

The purpose of this study was to determine changes in their cardiorespiratory function and body composition in female workers after aerobic exercise and circuit weight training. The subjects of this study were 16 female workers in B city and was divided into exercise and control groups which were composed of 8 people respectively. The members of exercise group had aerobic exercise and circuit weight training an hour a day, 5 days per week, for 8 weeks while controled group did not. Both groups were pretested and posttested, and the results of this study on cardiorespriatory function and body composition are as follows. Exercise group showed significant decrease in heart rate at rest($p<.001$). Exercise group showed significant increase in the oxygen uptake at rest, in the maximum oxygen uptake and in the vital capacity($p<.001$). Exercise group showed significant decrease in the %fat and fat($p<.001$). Exercise group showed significant increase in the %LBM and LBM($p<.001$).

Key words – Aerobic exercise, CWT(circuit weight training), VO_2max, %fat, LBM(lean body mass)

Introduction

Urbanization and technology resulted in changes of whole social living style. Considerable people suffer from the insufficient for the physical activity and live a sedentary life style.

The demand for health of body is becoming more important as the state of food, clothing, and housing grows stable in modern life. The consciousness of hypokinetic has been raised more than ever, especially because of the increase of the national income of our people. Moreover, it can be the instinctive desire of human who would live longer to have healthy body.

Therefore, humans in modern society should develop their own physical strength artificially to maintain and improve their body in health, so physical activities as well as an adequate nutrition are required earnestly.

The heart and lung endurance - maximum oxygen uptake - can be measured or estimated so as to examine the ability of maintaining essential work in daily life.

Shephard20] investigated on the exercises which were divided into 80%, 50% and 30% of VO_2max according to the intensity of the exercises. The result was like this ; the exercises of 80% VO_2max was the most efficient, that of 50% VO_2max was next to that, and that of 30% had little effect.

The American College of Sport Medicine suggests that one practical way of assessing the intensity level of exercise is to use a percentage of maximal heart rate (HRmax). According to the ACSM, 55% of HRmax corresponds to 40% of VO_2max, 70% HRmax to 60% VO_2max, 85% HRmax to 80% VO_2max, and 90% HRmax to 85% VO_2max, for the general population. These target

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values of %HRmax are based on the studies that determined regression equations for %HRmax vs %VO_2max[3,10,15,22,24].

Circuit training is a method to improve muscular strength and endurance by Morgan R. E. and G. T. Adamoson in United Kingdom and it is used along with circuit weight training. It aims at development of muscles and nervous system which can be the basis to enforce essential ability for exercise rather than promotion or development of physical strength needed for a certain kind of competition or activity.

Fats can be classified into essential and depot fats. Essential fat exists in bone marrow, nervous tissues and other organs, while depot fat is stored as energy in adipose tissues. There is no difference in the volume of depot fat between men and women. In contrast, the volume of essential fat of women is four times larger than men. This is probably related with the protection of female genital organs.

Obesity may be caused by the enlargement or number increase of adipocytes or by both. Recently there are many observations about trends of fat tissues' enlargement and growth after birth. The size and number of fat cells were increased by 4 to 5 times when a child grew up to an adult. Experiments with animals suggested that childhood before adolescence is the most important period in controlling obesity. The number of fat cells is stably maintained during adulthood. The mechanism of adult obesity lies in the enlargement of fat cells. It is necessary to prevent fat cells from being increased in number before children become biologically mature.

A number of researchers have studied respiratory and circulatory functions and physical components. But there have been few studies about aerobic exercise and circuit weight training which are combinedly provided as part of programs at health centers that are frequently used by people for their health maintenance and promotion. For this reason, the purpose of this study is to clarify how the combined provision of aerobic exercise and circuit weight training, which aims at improving respiratory and circulatory functions closely related to physical power, changes body fat influencing adult diseases much.

Materials and Methods

Subject

The subjects of this study were female workers who didn't join any sport activity and the members of S sport center in Busan. There were eight women in both controled and exercise groups.

The physical characteristics of subject are shown at (Table 1).

Measurement Items and Methods

This study was about the effects of aerobic exercise and circuit weight training. At first, both exercise and controled group were pretested to estimate vital capacity(VC), oxygen uptake at rest and exercise, heart rate(HR), respiratory rate(RR), ventilation(Ve). The exercise group took exercises five times a week and for one hour in a day. The intensity of exercise during the aerobic exercise were measured using PE3000 heart rate measurement system for the purpose of keeping the intensity at 70 to 80% of HRmax. After that, posttest was

Table 1. Physical characteristics of subjects

Group	Age (yrs)	Height (cm)	Body weight(kg)	%Fat (%)	HRrest (bpm)	HRmax (bpm)	BPrest(mmHg)	
							systolic	diastolic
Exercise(n=8)	25.8±1.67	162.1±2.13	58.5±2.39	25.3±2.14	74.5±5.26	191.9±2.42	111.5±8.35	68.3±3.11
Control(n=8)	24.4±0.92	165.5±3.01	56.9±2.38	23.6±2.53	71.1±3.23	191.0±2.27	109.8±10.28	68.9±2.90

given to both groups to examine the same parts as above.

The exercise prescriptions used in this study are as follows.

Aerobic Exercise (30 minutes)

One station was composed of run race 14 min, bicycle ergometer 7 min, row race 5 min.

The time for rest was 2 minutes.

Circuit Weight Training (30 minutes)

One station was composed of chest press, pectoral press, lat machine, triceps press, horizontal leg press, leg extension, leg curl, seated row machine, abdominal machine.

One station lasted 30 seconds and this was done 15 times.

The time for rest was 15 seconds and total station consisted of 5 sets.

Measurement of Cardiorespiratory

The exercise was done in Bruce protocol(inclination 3%) by the treadmill. Oxygen champion(Jager, German) was used for cardiorespiratory function.

Measurement of Vital Capacity

The vital capacity was measured by Spirometa program.

Measurement of Body Composition

The body composition was measured by Impemeter (ss110, Japan).

Statistical Analysis

Data obtained here were statistically processed through SAS package. Measurement for each of the groups were treated to obtain their mean value and standard deviation. Such difference between of the group were investigated thought t-test.

Results

Change in the oxygen uptake

The exercise group showed a significant increase in the VO_2 during the rest by 0.04 ℓ/min(16.67%) from 0.24 ±0.01% to 0.28±0.01 ℓ/min($p<.01$), during the maximal exercise test by 0.18 ℓ/min(6.67%) from 2.70±0.06 ℓ to 2.88±0.05 ℓ/min($p<.001$), while the control group showed a very minute increase by 0.01 ℓ (0.36%) from 2.74±0.08 to 2.75±0.08 ℓ with no significance(Table 2).

Change in the ventilation

The exercise group showed a significant decrease in the ventilation during the rest by 0.66 ℓ (7.22%) from 9.19 ±0.64 to 9.80±0.59 ℓ ($p<.001$), while the control group showed a slight increase by 0.30 ℓ (3.35%) from 8.96± 0.24 to 9.26±0.46 ℓ with no significance.

During the maximal exercise test showed a significant increase in the ventilation by 4.00 ℓ (4.38%) from 91.25± 3.43 to 95.25±2.73 ℓ ($p<.05$), while the control group showed a very small increase by 0.47(0.53%) from 89.16 ±2.40 to 89.63±2.63 ℓ with no significance(Table 3).

Change in the Heart rate

The exercise group showed a significant decrease in

Table 2. Comparison of difference between mean score on pre and post VO_2 test for subjects

Variable	Group		Pre	Post	Diff	%Diff	t
VO_2 (ℓ/min)	Exercise	rest	0.24±0.01	0.28±0.01	0.04	16.67	-8.84**
		maximal	2.70±0.06	2.88±0.05	0.18	6.67	-9.35***
	Control	rest	0.26±0.01	0.26±0.01	0	0	0
		maximal	2.74±0.08	2.75±0.08	0.01	0.36	-1.15

**: $p< .01$, ***: $p< .001$.

Table 3. Comparison of difference between mean score on pre and post ventilation test for subjects

Variable	Group		Pre	Post	Diff	%Diff	t
V_E (ℓ/min)	Exercise	rest	9.19±0.64	9.80±0.59	-0.66	7.22	-12.77***
		maximal	91.25±3.43	95.25±2.73	4.00	4.38	-3.40*
	Control	rest	8.96±0.24	9.26±0.46	0.30	3.35	-1.65
		maximal	89.16±2.40	89.63±2.63	0.47	0.53	-1.07

*: p< .05, ***: p< .001.

the Heart rate during the rest by 4.50bpm(6.04%) from 74.50±5.26 to 70.00±4.79bpm(p<.001), while the control group showed a minute decrease by 0.50bpm(0.70%) from 71.13±3.23 to 70.63±3.78bpm with no significance (Table 4).

Change in the vital capacity

The exercise group showed a significant increase in the vital capacity by 108cc(3.35%) from 3,247.50±219.46 to 3,356.25±215.14cc(p<.001), while the control group showed a very trifling increase by 17.50cc(0.53%) from 3,285.00±165.36 to 3,302±101.10cc with no significance (Table 5).

Changes in the Ratio and Volume of Body Fat

The exercise group showed a significant decrease in the ratio of body fat by 2.06%(8.15%) from 25.29±2.14 to 23.23±1.97%(p<.001), while the control group showed a insignificant decrease by 0.21%(0.89%) from 23.59±2.53 to 23.38±2.20% with no significance.

The exercise group showed a significant decrease in the volume of body fat by 2.08kg(14.03%) from 14.83±1.82kg to 12.75±1.55kg, while the control group showed a little increase by 0.20kg(1.49%) from 13.45±1.99kg to 13.25±1.66kg with no significance(Table 6).

Changes in the Ratio and Volume of Lean Body Mass

The exercise group showed a significant increase in the ratio of lean body mass by 2.07%(2.77%) from 74.71 ±2.14% to 76.76±1.97%(p<.001), while the control group showed a very slight increase by 0.22%(0.29%) from 76.41±2.53 to 76.62±2.20% with no significance.

The exercise group showed a significant increase in the volume of lean body mass by 1.63kg(3.73%) from 43.65±0.86 to 42.02±1.14kg(p<.001), while the control

Table 4. comparison of difference between mean score on pre and post heart rate test for subjects

Variable	Group		Pre	Post	Diff	%Diff	t
HR (bpm)	Exercise	rest	74.50±5.26	70.00±4.78	-4.50	6.04	7.94***
		maximal	191.88±2.42	192.63±2.83	0.75	0.39	-0.94
	Control	rest	71.13±3.23	70.63±3.78	-0.50	0.70	1.00
		maximal	191.00±2.27	191.50±2.00	0.50	0.26	-1.08

**: p< .01, ***: p< .001.

Table 5. Comparison of difference between mean score on pre and post vital capacity test for subjects.

Group	Variable	Pre	Post	Diff	%Diff	t
Exercise	VC	3,247.50±219.46	3,356.25±215.14	108.75	3.35	10.99***
Control	VC	3,285.00±165.36	3,302.50±101.10	17.50	0.53	0.53

***: p <.001.

Table 6. Comparison of difference between mean score on pre and post %fat and fat mass test for subjects

Variable	Group	Pre	Post	Diff	%Diff	t-value
%Fat(%)	Exercise	25.29±2.14	23.23±1.97	-2.06	8.15	12.61***
	Control	23.59±2.53	23.38±2.20	-0.21	0.89	1.45
Fat mass(kg)	Exercise	14.83±1.82	12.75±1.55	-2.08	14.03	16.23***
	Control	13.45±1.99	13.25±1.66	-0.20	1.49	1.63

***: p<.001.

Table 7. Comparison of difference between mean score on pre and post %LBM and LBM test for subjects

Variable	Group	Pre	Post	Diff	%Diff	t-value
%LBM(%)	Exercise	74.71±2.14	76.77±1.97	2.06	2.77	-12.61***
	Control	76.41±2.53	76.62±2.20	0.21	0.29	-1.45
LBM(kg)	Exercise	43.65±0.86	42.02±1.14	-1.63	3.73	7.84***
	Control	43.40±1.08	43.31±1.18	-0.09	0.21	1.08

***: p<.001.

group showed a very small decrease by 0.09kg(0.21%) from 43.40±1.08kg to 43.31±1.18kg with no significance(Table 7).

Discussion

At first, the maximum oxygen uptake was measured in order to estimate cardiorespiratory function. VO_2max means the maximum amount of O_2 which can be supplied to organism when an individual does exercise and it has been used as a good index to estimate effects of exercise as well as abilities of exercise. In addition, the oxygen uptake was measured to make it cleat what effects aerobic exercise and circuit weight training might caught in this study. The pretest and posttest showed the significant differences between the Means -2.70±0.06 ℓ/min and 2.88±0.05 ℓ/min, respectively as shown at (Table 2). Ko[12] had the same result from the study about 12 middle-aged women who went though the 80~90% HRmax training for 12 weeks. The maximum ventilation when doing exercise changed from 91.25±2.73 ℓ/min to 95.25±2.73 ℓ/min as shown at (Table 3). Velasquez[26] reported that VO_2max and VEmax were effective after 70~80% HRmax aerobic training 4 times a week for 9 weeks. Karvitz[9] found that cardiorepiratory function of women was improve after they had step aerobic exercise half an hour per day for 8 weeks. As shown at (Table 2), the heart rate at was changed from 74.50±5.26 beats/min to 70.00±4.78 beats/min and Lee[14] also found that long-term training helped rate and blood pressure decreased at rest and exercises. Moreover, Gettman[4]. announced that the exercise group showed higher score and decreased heart rate at rest.

The Mean changed from 191.88±2.42 beat/min to 192.63±2.83 beat/min but it is meaningfulless. Kim[11] also founded the same result ; the Mean increased from 169.80±13.97 beat/min to 169.80±16.48 beat/min and little changed.

The improvement of heart and lung endurance through aerobic exercise and circuit weight training seems to increase the amount of blood and develop the ability of respiration in muscles[21]. Vital capacity means the maximum amount of air which can be let out from the lung. It is divided into expiratory VC and inspiratory VC. The former must be measured while a person is exhaling and the latter while inhaling. Vital

capacity is widely used because it can be the typical standard of respiratory function as well as related to development of body and physical strength. As shown at (Table 5), vital capacity widely used index of respiratory function changed from 3,247.50±219.46cc to 3,356.25±215.14cc by 108.75cc(3.35%).

Let's consider the change of ventilation in normal people. Ventilation can be changed by regular respiratory rate and respiratory rate per minute. The increase of regular respiratory rate is closely related with ventilation, so it can be increased to 50%. It is mainly due to the increase of regular respiratory rate under anaerobic threshold.

Those who have exercised for a long time have strong muscles to extract arterial blood and increased amount of blood from heart(cardiac output) compared with normal people. Therefore, those who have been trained have more VO_2max than normal people, and VO_2max is widely used to estimate individual ability to inhale oxygen(aerobic capacity) and effects of training. In general, 70% of VO2max in normal people is determined by amount of blood from heart(cardiac output), and the rest, 30%, is related with organic ability to extract O_2. Active person has higher VO2max than inactive one and it is higher in men than in women. In addition, an inactive person can increase VO_2max up to 30% though training.

The amount of O_2 consumption in muscles is determined by the difference of O_2 content that shows toe amount of blood from heart and the ability to extract O_2, When exercising, both of them increase, so consequently VO_2 is also increased. The increase of amount of blood from heart is mainly due to increase of heart rate rather than stroke volume in normal people.

Gutin[5] insisted that the increase of maximum ventilation after training was just a side effect which could be the result of maximum oxygen uptake and that maximum ventilation is increased through training. Park[17] found that maximum ventilation showed meaningful increase though training, and Cheryl[1] reported that endurance exercise athletes had a more considerable increase than non-endurance athletes. Moreover, low heart rate at rest represents wide range of that at the maximum heart rate after exercising and it shows the ability of long-term exercise. This kind of heart which has been developed through exercise is called Athletic Heart. Oxygen uptake is increased as heart is developed.

In this study, while the cardiorespiratory function was not improved in the controled group which did not had aerobic exercise and circuit weight training, that was done in the exercise group ; this was the result of aerobic exercise and circuit weight training.

Decrease in the quantity of motion in daily life leads to increase in hypokinetic diseases such as obesity, diabetes mellitus, hypertension and ischemic heart disease. It was reported that obese people have a shorter life span and are more likely to be complicated with diabetes, hyperlipidemia, hypertension, arteriosclerosis and fatty liver than normal people.

The development of scientific civilization has brought decreased physical activities. This leads to reduced energy consumption and unbalanced energy, ultimately resulting in obesity. Much of energy taken into the body is accumulated in the form of fat, causing many different adult diseases.

Obesity can be treated through alimentotherapies including low calorie diet(LCD) and very low calorie diet (VLCD), exercise cure, behavioral modification, medication and operation[23]. Medication is little used because it has few effects, but many side effects. Operation is applied only if obesity is excessive enough to threaten life[7]. Although effective in losing weight, alimentotherapy has disadvantages of lowering the efficacy of basal metabolism in a stable state and decreasing body fat and lean body mass. It has been suggested that maintaining lean body mass while losing weight requires the simultaneous application of aerobic

exercise and alimentotherapy[2].

Thus this study tried to determine effects of aerobic exercise and circuit weight training on physical components to find that after the exercise and training over 8 weeks, the ratio and volume of body fat were significantly decreased($p<.001$) while lean body mass and its ration, significantly increased($p<.001$).

Schwartz et al.[19] reported that the ratio of circumference decrease at the mid-part of the body was higher than that of such decrease at the limbs, adding that young men showed decreases in abdominal splanchnic fat, abdominal hypodermic fat and femoral hypodermic fat by 21, 10 and 20%, respectively, after participating in exercises for endurance improvement over 6 months.

In a study about the distribution of body fat in accordance with gender, Krotkiewski et al.[13] found that Swedish men aged 52 had more fat cells and more hypodermic fat in the abdomen, while Swedish women aged 52 in the hip and femoral region. They also reported that body fat tended to be accumulated into the trunk, especially the abdominal region, over years.

Concerning relations between aerobic exercise and body fat, Nindle[16] reported that 31 women lost their weight by 2.3 kilograms in average after engaging in aerobic and resistance exercises simultaneously over 24 weeks on the basis of 5 sessions per week.

Han[6] applied a 12 weeks' session of CWT to the obese, thin and normal groups. As a result, it was found that the obese group were significantly higher in %fat, BMI and body weight than the thin group and that the obese group were significantly higher in %fat than the normal group, demonstrating that body fat is decreased and lean body mass is decreased[25] or maintained[18] through such process as CWT.

The control group to which aerobic exercise and circuit weight training were not applied did not show any changes in their physical components. In contrast, the exercise group which was under the application for 1 hour a session, 5 sessions a week over total 8 weeks showed significant decreases in the ratio and volume of body fat($p<.001$) and significant increases in lean body mass and its ratio($p<.001$).

Such significant decreases and increases in part of the exercise group could be attributed to aerobic exercise and circuit weight training which were implemented for 1 hour a session, 5 sessions a week over total 8 weeks.

The exercise and training had effects such as functional improvements of respiratory and circulatory systems and decrease in the volume of body fat which was related to adult diseases. Many indoor health centers provide opportunities of enjoying aerobic exercise and circuit weight training in all seasons. This makes it possible for modern people to prevent hypokinetic diseases and raise their low endurance and muscle power.

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초록 : 유산소운동과 Circuit Weight Training이 직장여성의 호흡순환기능 및 신체조성에 미치는 영향

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유산소운동과 서어킷 웨이트 트레이닝이 호흡순환기능과 신체조성에 미치는 영향을 알아보기 위하여 P시에 거주하는 직장여성 16명을 대상으로, 8명을 운동군으로 나머지 8명을 통제군으로 하여 운동군에게는 1일 1시간씩, 주당 5일, 8주간의 유산소운동(70%~80%HRmax)과 서어킷 웨이트 트레이닝(1RM의 40%~50%)을 실시하였다. 두 군 모두 pretest와 posttest를 실시하여 호흡순환기능과 신체구성의 변화를 비교·분석한 결과, 운동군에서는 안정시의 심박수는 유의하게 감소하였고($p<.001$), 산소섭취량, 환기량 그리고 폐활량은 유의하게 증가하였다($p<.001$). 최대운동시 산소섭취량도 운동군에서는 유의한 증가가 나타났다($p<.001$). 또한 운동군에서는 체지방률과 체지방량은 유의하게 감소한($p<.001$) 반면 제지방률과 제지방량은 유의하게 증가하였다($p<.001$).

이상의 결과에서 유산소운동과 저항성운동의 복합 프로그램은 직장여성의 심폐기능 향상과 체지방 감소에 긍정적인 영향을 미치는 것으로 나타났다.