CRAE Training Reduces Insulin Resistance and Central Adiposity in Obese Adolescent Females

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ABSTRACT

Exercise training is recommended for maintaining health and reducing the risks of developing metabolic and cardiovascular pathologies. Combined resistance and aerobic exercise (CRAE) training has been utilized to decrease metabolic risk factors in obese adults.

PURPOSE: To determine the effects of CRAE on obese adolescent females with hyperinsulinemia. **METHODS:** Forty obese adolescent females aged 14.7 ± 1 years (BMI 30 ± 2 kg/m^2) were randomly assigned to the exercise group (EX, n = 20) or the control group (CON, n = 20). The EX group performed CRAE 5 days a week for 12 weeks. The intensity gradually increased by 10% every 4 weeks, from 40 – 70% of their heart rate reserve (HRR). Body composition, blood pressure (BP), heart rate (HR), brachial-ankle pulse wave velocity (BaPWV), blood leptin, adiponectin, glucose, and insulin were measured pre- and post-training. **RESULTS:** CRAE reduced the body fat percentage, body weight, and waist circumference of the EX group ($p < 0.05$) compared to the CON group after 12 weeks of testing. EX maintained appropriate levels of blood leptin and adiponectin while their insulin, glucose, and insulin resistant parameters decreased compared to their baseline and the control group ($p < 0.05$). **CONCLUSION:** These data show that CRAE is a safe and useful therapeutic method to improve metabolic risk factors of obese adolescent females with hyperinsulinemia.

INTRODUCTION

Obesity has doubled in children and quadrupled in adolescents in recent decades. Obesity leads to cardiovascular complications, high blood pressure, high cholesterol, type 2 diabetes, and metabolic syndrome. Obese children are more likely to remain obese into adulthood making them more susceptible to several metabolic diseases. CRAE training promotes additional benefits when compared to resistance only or aerobic only training in terms of weight loss, fat loss, and cardiovascular fitness. In previous studies, CRAE training reduced percent body fat, waist circumference, blood pressure, arterial stiffness, and functional capacity in older adults. The purpose of this study was to determine the effects of CRAE training on obese hyperinsulinemic adolescent females.

METHODS

- Forty sedentary adolescent females (14.7 ± 1 yrs) who were obese (BMI ≥ 30 kg/m^2), with hyperinsulinemia (> 12.0 µU/ml), and abdominal obesity (waist > 80 cm) participated in this study.
- Venous blood samples, waist circumference measurements, and body composition via BIA were taken pre- and post-training.
- Plasma insulin concentration was measured in duplicate using radioimmunoassay kits.

METHODS

- Insulin resistance (IR) was estimated using the homeostasis model assessment of IR (HOMA-IR).
- Plasma leptin and adiponectin concentrations were analyzed via enzyme-linked immunosorbent assay (ELISA).
- Vascular function was measured via brachial artery pulse wave velocity (baPWV) using a applanation tonometer.

Table 1. Exercise training protocol (5 days/week, 12 weeks)

Order	Exercise	Duration	Intensity	Repetitions
Warm-up	Static Stretching	5 min		
Upper Body Resistance	Seated Rows Bicep Curl Shoulder Flexion Tricep Extension Push-up	20 min	Weeks 1-4: 40-50% HRR (RPE 11-12)	15-20
Lower Body Resistance	Hip Flexion Hip Extension Calf Raise Leg Press Squat	20 min	Weeks 5-8: 50-60% HRR (RPE 13-14)	15-20
Aerobic Exercise	Walking/Jogging	30 min	Weeks 9-12: 60-70% HRR (RPE 15-16)	
Cool-down	Static Stretching	5 min		

HRR - heart rate reserve, RPE - rating of perceived exertion (Borg Scale 6-20)

RESULTS

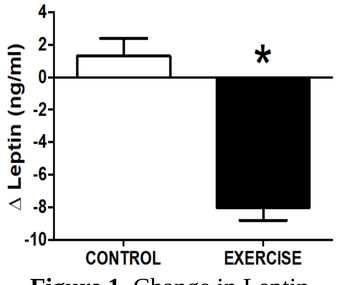

Figure 1. Change in Leptin Post-Training

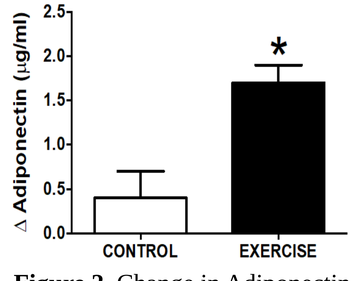

Figure 2. Change in Adiponectin Post-Training

RESULTS

Table 2. Metabolic measurements of control and exercise groups pre- and post-training (n = 40)

	Control (n = 20)		Exercise (n = 20)	
	Pre-	Post-	Pre-	Post-
Glucose (mmol/L)	5.6 ± 0.2	5.4 ± 0.1	5.5 ± 0.1	4.3 ± 0.2*ǂ
Insulin (µU/ml)	26.2 ± 3.2	27 ± 2.4	27.4 ± 2.2	10.3 ± 2.1*ǂ
HOMA-IR	6.4 ± 0.4	6.5 ± 0.6	6.7 ± 0.5	1.9 ± 0.7*ǂ
Leptin (ng/ml)	21.2 ± 2.4	22.5 ± 2.3	20.8 ± 2.1	12.8 ± 1.4ǂ
Adiponectin (µg/ml)	5.3 ± 0.8	5.7 ± 0.5	6.8 ± 0.6	8.5 ± 0.1ǂ
A/L ratio	0.25 ± 0.02	0.25 ± 0.05	0.33 ± 0.04	0.66 ± 0.09*ǂ
SBP (mmHg)	122 ± 1.3	124 ± 1.4	121 ± 1.4	120 ± 0.4
DBP (mmHg)	80 ± 2.2	80 ± 2.4	80 ± 1.6	78 ± 1.55
baPWV (m/s)	8.3 ± 1	8.4 ± 1	8.5 ± 1.2	8.4 ± 1
HR (bpm)	68 ± 3	69 ± 2	68 ± 2	67 ± 1

Mean ± SEM, A/L = adiponectin/leptin ratio, SBP = systolic blood pressure, DBP = diastolic blood pressure, HR = heart rate

*$p < 0.05$ vs. Pre, ǂ$p < 0.05$ vs. Control

Table 3. Descriptive measurements of exercise and control groups pre- and post-training (n = 40)

	Control (n = 20)		Exercise (n = 20)	
	Pre-	Post-	Pre-	Post-
Weight (kg)	75.6 ± 2.8	75.8 ± 1.5	76.4 ± 2.8	70.2 ± 2.9*ǂ
BMI (kg/m^2)	30 ± 1.2	30 ± 1.4	30 ± 2.2	27 ± 2.1*ǂ
% BF	43.4 ± 2.2	43 ± 2.2	43 ± 2.3	39.6 ± 2.1*ǂ
WC (cm)	87.3 ± 1.5	88.2 ± 1.0	87.6 ± 0.7	83.5 ± 0.5*ǂ
VO_{2max} (ml/kg/min)	25 ± 2.4	26 ± 2.1	25 ± 1.7	27 ± 1.2*

Mean ± SEM, BMI = body mass index, BF = body fat, WC = waist circumference

*$p < 0.05$ vs. Pre, ǂ$p < 0.05$ vs. Control

CONCLUSIONS

- CRAE training improves the satiety hormones leptin and adiponectin.
- CRAE training effectively reduces percent body fat, body weight, waist circumference, and significantly reduces HOMA-IR which reduces risks for metabolic syndrome.
- 12 weeks of CRAE training restores insulin and glucose homeostasis.
- CRAE training that incorporates modes other than resistance bands and a walking protocol may prove to induce similar or greater results.
- Future studies can determine the effect of CRAE training on females and males of different age groups with varying levels of health and fitness.