SHORT REPORT

The influence of physical training modalities on basal metabolic rate and leptin on obese adolescent boys

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Abstract

The aim of this study was to investigate the effects of physical training modalities on basal metabolic rate, cardiovascular fitness and serum leptin level in obese adolescent boys. Sixteen obese adolescent boys (age: 16.81 ± 0.91 years) were randomly assigned to either resistance (RTG) (n=8) or endurance (ETG) (n=8) training and followed the respective training programmes for six months (3 days/wk, 60 min/day). Leptin, basal metabolism rate (BMR), and maximum oxygen consumption (VO_{2max}) were evaluated at the beginning and end of the intervention. After the training period, Leptin was decreased and VO_{2max} was increased in both groups ($p<0.05$), whereas BMR was statistically increased only in ETG ($p<0.05$). These results indicated that both types of exercises had positive effects on cardiovascular fitness and hormonal control of fat metabolism in obese male adolescents. Resistance exercises should be considered as an alternative or supplementation to endurance exercises in youth obesity management.

Keywords: Resistance Training, Endurance Training, Leptin, Basal Metabolic Rate, Obesity

Introduction

The worldwide epidemic of youth obesity calls for investigation of metabolic mechanisms that control energy balance and implementation of counter measures. Leptin controls body weight by reducing food intake through hypothalamic receptors and increases metabolic rate,[1] and obese subjects have higher leptin levels than non-obese ones.[2] Studies on the effects of exercise on serum leptin levels in obese children and youth are not equivocal; some have found decreasing,[3] others stated unchanged leptin levels after endurance exercise.[1]

A better understanding of the metabolic responses to different types of exercise training may help tailor interventions to maximize the likelihood of achieving health benefits among obese adolescents. Within this context, the main purpose of this study was to compare the effects of structured six-month resistance versus endurance-training programmes on leptin, maximum oxygen consumption (VO_{2max}), and basal metabolic rate (BMR).

Methods and Results

Sixteen adolescent boys (age: 16.81 ± 0.91 years) without prior sport experience participated voluntarily in this study. They were selected for being over the 95% percentile of body mass index at any age.[4] The participants were randomly divided into two training groups, resistance-training (RTG) (n=8) and endurance-training (ETG) (n=8).

Leptin level was measured using type of DRG-Leptin (sandwich) ELISA kit (EIA-2395) (DRG Instruments GmbH, Germany). Body composition parameters were determined with a body composition analyzer (X-SCAN, Jawon Medical, Korea).

BMR measurements were made at the laboratory after 12 hours of fasting and ≥30 min of resting in a supine position on a bed, in absolute quietness and at thermal neutrality. Oxygen consumption and carbon dioxide production were measured every minute for 30 minutes by a calibrated Ergospirometer (ZAN® 680 USB, ZANMessgeraete, Oberthulba, Germany). BMR was calculated using Weir's equation.[5]

The participants were asked to complete a specific graded exercise treadmill test (Bruce protocol) on a RAM 770 treadmill (Model 770 M, RAM Medical and Industrial

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Table-1: Demographic and body composition variables of pretest and posttests for RTG (n = 8) and ETG (n = 8).

Variables	Groups	Pre exercise	Post exercise	p-values	
				Within group	Between group
Age (years)	ETG	17±0.7	17±0.8	0.78	0.624
	RTG	16.6±1.0	16.6±1.2	0.66	
Height (cm)	ETG	174.13±8.56	175.83±8.45	0.01 **	0.916
	RTG	176.11±7.87	177.89±7.60	0.01**	
Weight (kg)	ETG	97.69±13.95	96.50±10.63	0.67	0.372
	RTG	101.15±14.22	101.15±14.22	0.23	
BMI (m^2/kg)	ETG	32.19±3.24	31.24±2.51	0.2	0.318
	RTG	32.52±3.08	30.58±3.98	0.05*	
Percent body fat (%)	ETG	32.95±3.40	31.28±2.67	0.01 **	0.344
	RTG	33.05±3.42	30.44±5.22	0.05 *	
Body fat (kg)	ETG	32.46±7.53	30.25±5.37	0.06	0.674
	RTG	33.91±7.58	30.20±9.58	0.06	
Abdominal fat (kg)	ETG	5.58±1.78	4.94±1.18	0.06	0.636
	RTG	5.86±1.77	4.99±2.15	0.09	
Lean body mass (kg)	ETG	65.23±7.21	65.61±6.02	0.57	0.636
	RTG	67.24± 7.44	66.88±7.84	0.57	
Body muscle mass (kg)	ETG	59.70±6.48	61.51±6.71	0.44	0.636
	RTG	60.19±5.49	61.36±6.98	0.67	

Note. Data are presented as mean ±SD, RTG = resistance training group; ETG = endurance training group; BMI = body mass index.
* indicates significant difference within or between groups ($p \leq 0.05$)
** indicates significant difference within or between groups ($p \leq 0.01$).

Table-2: Leptin, VO_{2max} outcomes and basal metabolic rate variables of pretest and posttests for RTG (n = 8) and ETG group (n = 8).

Variables	Groups	Pre exercise	Post exercise	p-values	
				Within group	Between group
VO_{2max} (ml.kg/min)	ETG	31.80±4.40	38.40±5.87	0.012*	0.916
	RTG	32.08±6.76	37.99±6.38	0.012*	
VO_{2max} (l/min)	ETG	3066.32±282.17	3662.06±321.51	0.012*	0.916
	RTG	3200.91±586.38	3630.89±543.94	0.017*	
BMR (kcal/day)	ETG	1861.63±4.22.38	2124.25±577.38	0.036*	0.372
	RTG	1956±352.64	2111.75±594.02	0.779	
Leptin (ng/ml)	ETG	63.70±13.71	34.05±5.68	0.00*	0.442
	RTG	52.25±13.42	28.47±8.10	0.00*	

Note. Data are presented as mean ±SD, RTG = resistance training group; ETG = endurance training group, VO_{2max} = maximum oxygen consumption; BMR = Basal metabolic rate;
*indicates significant difference within or between groups ($p \leq 0.05$).

Instruments & Supply, Padova, Italy). Total run time in minutes was converted to oxygen consumption values according to Bruce protocol algorithm.

Both groups attended their own training programme for six months for three sessions per week (3 days/wk, 60 min/day). Exercise intensity of was controlled by Polar telemetric pulse meter (Polar S625x, Polar Electro Oy, Finland).

For the endurance exercise prescription, exercise intensity was designed for an intensity of 50% - 60% for the first two months, 60% - 70% for the third and fourth months, and for the fifth and sixth months at 70% - 75% of the maximum heart rate. Accordingly, the appropriate resistance exercise programme for each individual was established by calculating 50% - 60% of 1-RM (repetition maximum) during the first two months, 60% - 70% of 1-RM during the second two months, and 70% - 75% of 1-RM during the last two months.

A dietitian provided counseling and recommendations on balanced nutrition but a structured diet programme was not implemented throughout the study.

The nonparametric Wilcoxon matched-pairs signed test was used to assess the significance of the differences between the mean values of variables in the groups.

All participants were obese according to the international age-related cut-off points for childhood obesity.[4] BMI decreased significantly ($p<0.05$) between pre- and post-tests for the RTG group. Percent body fat decreased significantly ($p<0.05$) after training in both groups whereas weight, body fat, and fat-free mass did not change ($p>0.05$) (Table-1).

Both in the ETG and RTG, there were significant differences between pre- and post-test values for leptin ($p<0.05$). BMR increased significantly ($p<0.05$) by 14.75% in the ETG, but not in the RTG group (9.8%). The post-test values for VO_{2max} increased significantly in both groups ($p<0.05$) (Table-2).

Discussion

Our findings are in agreement with previous reports presented by Ackel-D'Elia et al,[6] who demonstrated that leptin levels were reduced by both endurance training and endurance training combined with strength training in obese adolescents. In contradiction, Barbeau et al[7] and Lau et al[8] did not observe any weight loss and decrease in leptin levels after physical training. These controversial findings may be due to different patterns and durations of exercises, participants' nutritional status, physical activity or the circadian rhythm of leptin.

Regarding cardiovascular fitness, both of our 6-month training interventions were able to significantly increase absolute and relative VO_{2max}. The higher the cardiovascular fitness, the more protected one is against obesity risk factors. In this way, Aires et al[9] reinforce the importance of interventions that increase VO_{2max} in obese adolescents.

The resistance exercise protocol was not able to improve BMR, while the endurance exercise proved to be effective in increasing BMR. This is supported by the findings of Alberta et al.[10] who showed that 6 months of aerobic, resistance, or combined training with modest dietary restriction did not increase BMR compared with diet only in adolescents with obesity.

Conclusion

Our results indicate that both endurance and resistance exercises without caloric restriction were effective in reducing body fat percentage, increasing VO_{2max} and decreasing leptin levels in obese adolescent boys. Basal metabolic rate increased only by endurance training.

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Conflicts of Interest: None of the authors have any potential conflicts of interest associated with this research.

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