Exercise Biochemistry Review

Proceedings of IBEC 2018, Beijing, China, October 23-25
PO-092

Effects of hypoxic exercise on weight loss and lipid metabolism in overweight/obese men

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Objective In recent years, people's diet has undergone tremendous changes. Excessive energy intake combined with insufficient exercise has made obesity a serious social problem. This study aims to achieve different training conditions under hypoxia and normoxia， conducting a six-week exercise training for obese overweight people. Comparing the difference in exercise weight loss between obese and overweight people in the normoxia training environment compared with hypoxia intervention, and the effect of hypoxic intervention on lipid metabolism indicators in overweight and obese people.

Methods A total of 40 male overweight/obese subjects were enrolled in the study, aged 18-47 years, with no abnormal physical examination and no motor contraindications. The overweight standard is BMI≥24, and the obesity standard is BMI≥28.All subjects were randomly matched according to body weight, divided into hypoxia group and normoxia group, and exercised for 6 weeks, training 3 times a week, one time every two days. Sports training includes 30 minutes of strength training and 30 minutes of aerobic endurance training. There are 5 minutes of warm-up and finishing activities before and after training. The strength training tool is dumbbell, and the weight of the corresponding 12RM is selected according to the exercise ability of the subject, and 8 exercises are performed. They are dead lift, upright row, squat, shoulder press, calf Jump, advance lunge, biceps curl and triceps extension. Those 8 movements are divided into two small loop trainings, which complete two large groups (each small loop is completed twice).Aerobic endurance training is done using a treadmill with a slope of 0°and the speed is adjusted according to the range of the target heart rate. The target heart rate is 60%-70% at the maximum heart rate. The maximum heart rate calculation method is (220-age).The hypoxic group is equipped with a suction-type atmospheric hypoxic device and is operated under a low-oxygen environment. The oxygen content of the inhaled mixed gas is 16%, the normoxic group was exercised under normoxic conditions. Nutritional education was given to all subjects prior to the start of exercise intervention, but diet was not restricted during the intervention. Before and after intervention, height and weight were measured, and BMI was calculated. Fasting venous blood was used to detect total cholesterol (TC), total triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C), leptin (LEP) and adiponectin (ADPN). All test results are expressed as mean ± standard deviation. Comparison of data between groups, using nonparametric Mann-Whitney U test. Comparison of intra-group data, using non-parametric Wilcoxon matching for symbol level checking, the significance level was $P<0.05$, and the very significant level was $P<0.01$.

Results (1) After the intervention, the body weight of both groups decreased, and the Δbody weight ($P<0.01$), body weight change rate ($P<0.01$) and BMI change rate ($P<0.01$) in the hypoxic group were significantly higher than normal oxygen group. (2) TG, TC and LDL-C decreased in the hypoxic group, and there was a significant difference between TG and TC before intervention ($P<0.01$). There was no significant difference in TG, TC and LDL-C between the normoxic group and the intervention group ($P>0.05$). (3) The TG change rate ($P<0.05$), TC change rate ($P<0.05$) and LDL-C change rate ($P<0.01$) in the hypoxic group were significantly higher than those in the normoxic group. (4) HDL-C in hypoxia group and normoxia group decreased after intervention, and there was no significant difference between the two groups ($P>0.05$), and there was no difference between HDL-

C(P>0.05). (5) LEP and ADPN in the hypoxic group increased after intervention, but there was no significant difference compared with before intervention (P>0.05). LEP and ADPN in the normoxic group decreased after intervention, and there was no difference between the LEP change rate and the ADPN change rate (P>0.05).

Conclusions Under hypoxic intervention, the weight change, rate of change, and BMI change rate of overweight people were larger than those of the normoxic group. Body weight, BMI is a direct indicator of the degree of obesity in individuals. The hypoxic weight loss intervention shows greater advantages than the normoxic group from the intuitive data, which can help overweight and obese people to lose more weight under the same training load and intensity. After six weeks of training, in the hypoxic group, TC, TG and LDL-C decreased, and HDL-C increased. However, in the normoxic control group, these indicators did not show similar significant changes. It shows that through hypoxia intervention combined with exercise training, it can prevent and alleviate various chronic diseases caused by obesity more effectively, such as atherosclerosis. The other two indicators, LEP and ADPN, did not change significantly in both hypoxic and normoxic training. Conjecture there may be other mechanisms affecting the expression levels of these two hormones in the body. In summary, the researchers think the hypoxic exercise to lose weight is better than normal oxygen exercise, and it has a greater impact on most lipid metabolism indicators, which can stimulate most lipid metabolism to produce benign changes.