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Hypoxia exercise improves glucose metabolism in the overweight and obese women

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Objective With the increase of social pressure and the unreasonable diet structure, the proportion of the overweight and obese people is increasing. Obesity is an important factor causing many chronic diseases, such as type II diabetes, atherosclerosis, hypertension, hyperlipidemia and so on. Epidemiological studies show that the proportion of obese people in China is still high. It has seriously hindered the further development of the Chinese health. The combination of diet and exercise is effective for reducing the weight. However, this method isn't effective for overweight and obese people. Therefore, the way to reduce weight has become a central issue for many researchers. Studies have shown that the exposure of hypoxia condition can decrease weight and exercise can promote energy consumption. Exercises in a hypoxic environment provide a new way of thinking for the prevention and treatment of obesity and national fitness, and which are also a research hotspot for weight loss.

Methods The study enrolled 40 young women with overweight/obese subjects, aged 18-47 years, with no abnormal physical examination. The criterion for overweight is BMI ≥ 24 and the criterion for obesity is BMI ≥ 28. All subjects were paired according to their body weight, divided into hypoxia group and normoxia group and they exercised for 6 weeks, 3 times a week, every other day. The content of the exercise intervention includes 30 minutes strength training and 30minutes endurance training. Strength training is in front and endurance training is in the back. There are 5 minutes of warm-up and finishing activities before and after training. Strength training uses dumbbells, chooses 12RM weight, exercise with 8 actions, which are *dead lift*, upright row, squat, shoulder press, calf Jump, advance junge, biceps curl and triceps extension, each action 2 Group, rest between groups for 30s. Endurance training uses a treadmill with a slope of 0°, and the speed is adjusted according to the target heart rate interval. The calculation method of the target heart rate interval is (220-age)×60%～(220-age)×70%. Meanwhile, the hypoxia group wears inhaled atmospheric hypoxia equipment and they exercised in a low-oxygen condition. The oxygen content of the inhaled mixed gas is 16%; the normoxia group exercises under the normal oxygen condition. Nutritional education was given to all subjects prior to the start of exercise intervention and the personal diet was controlled as much as possible, but diet was not restricted during the intervention. Body weight was measured before and after intervention. Fasting venous blood was taken. Blood glucose (GLU), insulin (INS) and glycated hemoglobin (GHb) were measured. Insulin resistance index (HOMA-IR) was calculated. All test results were expressed as mean ± standard deviation, non-parametric Mann-Whitney U test was used for comparison between groups, and non-parametric Wilcoxon matching was used for symbol level test. The significance level was $P<0.05$, the level of very significant was $P<0.01$.

Results After intervention, the fasting blood glucose level of the hypoxia group and normoxia group decreased and the hypoxia group decreased more, but there was no significant difference compared with before intervention ($P>0.05$). There was no significant difference between the rate and the normoxia group ($P>0.05$). After intervention, the GHb levels in the hypoxia group and the normoxia group decreased, but there was a significant difference between the hypoxia group and the hypoxia group ($P<0.05$). The difference between the normoxia group was not significant ($P>0.05$). There was no significant difference in the rate of GHb change between the oxygen exercise group and the normoxia group ($P>0.05$). After intervention, the fasting INS levels in the hypoxia group and the

normoxia group decreased, but there was a significant difference between the hypoxia group and the hypoxia group (P<0.05), and the difference between the normoxia group was not significant (P>0.05). There was no significant difference in the rate of fasting INS between the hypoxia group and the normoxia group (P>0.05). The HOMA-IR of the hypoxia group and the normoxia group decreased after intervention, but there was significant difference between the hypoxia group and the hypoxia group (P<0.05) and the difference between the normoxia group was not significant (P>0.05). The HOMA-IR rate of hypoxia exercise was not significantly different from that of normoxia group (P>0.05).

Conclusions Compared with the normoxia group, the hypoxia group has a more improved glycosylated hemoglobin and insulin resistance index. It suggests that the exercise intervention of the hypoxia condition may be more effective in treating obesity and preventing chronic diseases.