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Effects of Exercise in the Cold on Glycolipid Metabolism and Insulin Sensitivity in Obese Rats

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Abstract : Objective: Cold exposure and exercise serve as two physiological stimuli to glycolipid metabolism and insulin sensitivity. So far, it remains to be elucidated whether exercise plus cold exposure can produce an addictive effect on promoting glycolipid metabolism and insulin sensitivity. Methods: 64 SD rats were subjected to high-fat and high-sugar diets for 9-week and sucessfully to establish an obesity model. They were randomly divided into 8 groups: normal control group (NC), normal exercise group (NE), continuous cold control group (CC), continuous cold exercise group (CE), acute clod control group (AC), acute cold exercise group (AE), intermittent cold control group (IC) and intermittent cold exercise group (IE). For continuous cold exposure, the rats stayed in a cold environment all day; for acute cold exposure, the rats were exposed to cold for only 4h before the end of the experiment; for intermittent cold exposure, the rats were exposed to cold for 4h per day. The protocol for treadmill runnings were as follows: 25m/min (speed), 0°C (slope), 30 mins each time, an interval for 10 mins between two runnings, twice/two days, lasting for 5 weeks. Sampling were conducted on the 5th weekend. Blood lipids, free fatty acids, blood glucose (FBG), and serum insulin (FINS) were examined, and the insulin resistance index (HOMA-IR = FBG (mmol/L)×FINS(mIU/L)/22.5) was calculated. SPSS 22.0 was used for statistical analysis of the experimental results, and the ANOVA analysis was performed between groups ($p < 0.05$ was significant). Results: (1) Compared with the NC group, the FBG of the rats was significantly declined in the NE, CE, AC, AE, and IE groups ($p < 0.05$), the FINS of the rats was significantly declined in the AE group ($p < 0.05$), the HOMA-IR of the rats was significantly declined in the NE, CE, AC, AE and IE groups ($p < 0.05$). Compared with the NE group, the FBG of the rats was significantly declined in the CE, AE, and IE groups ($p < 0.05$), the FINS and HOMA-IR of the rats were significantly declined in the AE group ($p < 0.05$). (2) Compared with the NC group, the CHO, TG, LDL-C, and FFA of the rats were significantly declined in CE and IE groups ($p < 0.05$), the HDL-C of the rats was significantly higher in NE, CC, CE, AE, and IE groups ($p < 0.05$). Compared with the NE group, the HDL-C of the rats was significantly higher in the CE and IE groups ($p < 0.05$). Conclusions: Sedentariness or exercise in the acute cold doesn't make sense in the treatment of type 2 diabetes, which led to one-off increases of the body's insulin sensitivity. Exercise in the continuous and intermittent cold can effectively decline the FBG, TC, TG, LDL-C, and FFA levels and increase the HDL-C level and insulin sensitivity in obese rats. These results can impact the prevention and treatment of type 2 diabetes.

Keywords : cold, exercise, insulin sensitivity, obesity
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