

Effects of Exercise Training in the Cold on Browning of White Fat in Obese Rats

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Abstract : Objective: Cold exposure and exercise serve as two powerful physiological stimuli to launch the conversion of fat-accumulating white adipose tissue (WAT) into energy-dissipating brown adipose tissue (BAT). So far, it remains to be elucidated whether exercise plus cold exposure can produce an additive effect on promoting WAT browning. Methods: 64 SD rats were subjected to high-fat and high-sugar diets for 9-week and successfully established 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), 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 intermittent cold exposure, the rats were exposed to cold for only 4h per day. The protocol for treadmill exercises were as follows: 25m/min (speed), 0°C (slope), 30mins each time, an interval for 10 mins between two exercises, twice/two days, lasting for 5 weeks. Sampling were conducted on the 5th weekend. The body length and weight of the rats were measured, and the Lee's index was calculated. The visceral fat rate (VFR), subcutaneous fat rate (SFR), brown fat rate (BrFR) and body fat rate (BoFR) were measured by Micro-CT LCT200, and the expression of UCP1 protein in inguinal fat was examined by Western-blot. 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 weight of obese rats was significantly declined in the NE, CE and IE groups ($P < 0.05$), the Lee's index of obese rats significantly declined in the CE group ($P < 0.05$). Compared with the NE group, the weight of obese rats was significantly declined in the CE and IE groups ($P < 0.05$). (2) Compared with the NC group, the VFR and BoFR of the rats significantly declined in the NE, CE and IE groups ($P < 0.05$), the SFR of the rats significantly declined in the CE and IE groups ($P < 0.05$), and the BFR of the rats was significantly higher in the CC and IC groups ($P < 0.05$), respectively. Compared with the NE group, the VFR and BoFR of the rats significantly declined in the CE group ($P < 0.05$), the SFR of the rats was significantly higher in the CC and IS groups ($P < 0.05$), and the BrFR of the rats was significantly higher in the IC group ($P < 0.05$). (3) Compared with the NC group, the up-regulation of UCP1 protein expression in the inguinal fat of the rats was significant in the NE, CC, CE, IC and IE groups ($P < 0.05$). Compared with the NE group, the up-regulation of UCP1 protein expression in the inguinal fat of the rats was significant in the CC, CE and IE groups ($P < 0.05$). Conclusions: Exercise in the continuous and intermittent cold, especially in the former, can effectively decline the weight and body fat rate of obese rats. This is related to the effect of cold and exercise on the browning of white fat in rats.

Keywords : cold, browning of white fat, exercise, obesity

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