Research Paper

Effect of Eight Weeks of Aerobic Progressive Training with Capsaicin on Changes in PGC-1α and UPC-1 Expression in Visceral Adipose Tissue of Obese Rats With Diet

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ABSTRACT

Objective Decreased physical activity coupled with increased High-Fat Diet (HFD) intake prompts obesity. Current research suggests that changing White Adipose Tissue (WAT) to brown promotes energy expenditure to counter obesity. The purpose of this study was to investigate the effects of aerobic Progressive training and Capsaicin (Cap) on Peroxisome proliferator-activated receptor Gamma Coactivator 1-alpha (PGC-1α) and Uncoupling protein-1 (UPC-1) gene expression in rat fed a high-fat diet.

Methods 40 male Wistar rats aged 8-12 weeks, were fed a Normal Diet (ND) (n=8) or HFD (n=32) for 8 weeks. After 8 weeks, rats were divided into 5 groups: ND, HFD, High-Fat Diet-Training (HFDT), High-Fat Diet-Capsaicin (HFDCap), High-Fat Diet-Training-Capsaicin (HFDTCap). Training groups have performed a progressive aerobic running program on a motor-driven treadmill for eight weeks. Capsaicin (4 mg/kg/day) were administered orally, by gavage, once a day. PGC-1α and UCP-1 gene expression levels in the VAT were measured by Real-time PCR method.

Results The results of this study showed that PGC-1α and UCP-expression was decreased in HFD group compared to ND group. Also, the expression of PGC-1α and UPC-1 in HFDT, HFDCap and HFDTCap groups was significantly increased compared to HFD. The expression of PGC-1α and UPC-1 in HFDTCap was also significantly increased compared to HFDT and HFDCap groups.

Conclusion Possibly, eight weeks of progressive training combined with capsaicin administration has an effect on the browning of visceral adipose tissue in HFD rats by increasing expression of PGC-1α and UCP-1.

Extended Abstract

1. Introduction

Obesity is caused by an imbalance between energy intake as a result of overeating or reduced levels of physical activity. White and brown fat cells are two different types of fat cells with opposite functions. White fat is a storehouse of extra energy, while brown fat increases the oxidation of fatty acids and their production by heat through Unpaired Protein-1 (UCP-1) into the mitochondria, thereby reducing the substrate for storage in WAT [5]. The role of PGC-1α in the conversion of WAT to brown has been confirmed [8]. Increased expression of PGC-1α increases FNDC5, which breaks down from the cell membrane and is secreted into the bloodstream called irisin [8]. PGC-1α-induced irisin promotes UCP-1 protein expression

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and increases mitochondrial contents. UCP-1 is an important protein involved in the regulation of brown fat thermogenesis and the ability to convert WAT to brown adipose tissue [8]. The researchers showed that training on a treadmill increased the expression of PGC-1α [11] and UCP-1 [13]. In addition to exercise, studies have shown that the activity of brown adipose tissue with various nutrients, such as capsaicin in red pepper, increases [19]. Despite the physiological effects of capsaicin and adaptations due to long-term exercise, the simultaneous effect of exercise and capsaicin on fat phenotype change indices in the obese rat model has been less studied. Therefore, this study intends to investigate the effect of aerobic exercise with capsaicin on the expression of PGC-1α and UCP-1 gene in visceral adipose tissue in obese model mice.

2. Materials and Methods

Fourty male rats (5 weeks old, weight 147.68 9 9.41) after adaptation to environmental conditions were divided into two groups: normal diet (n=8, ND) and high fat diet (n=32, HFD). HFD rats were fed a high-fat diet for eight weeks. After eight weeks, all mice were divided into 5 groups: Normal Diet (ND), High-Fat (HFD), High-Fat-Training (HFDT), High-Fat-Capsaicin (HFDCap) and High-Fat-Training-Capsaicin (HFDTCap). Training groups have performed a progressive aerobic running program (at 15-25 m/min, 30-60 min/day, and 5 days/week) on a motor-driven treadmill for eight weeks. Capsaicin (4 mg/kg/day) were administered orally, by gavage, once a day. PGC-1α and UCP-1 gene expression levels in the VAT were measured by Real-time PCR method. For statistical analysis, ANOVA were used with a significance level set at P<0.05.

3. Results

The results of this study showed that PGC-1α (P=0.000) and UCP-1 (P=0.000) expression was decreased in HFD group compared to ND group. Also, the expression of PGC-1α and UPC-1 in HFDT (Respectively P=0.032, P=0.000), HFDCap (Respectively P=0.027, P=0.048) and HFDTCap (Respectively P=0.000, P=0.000) groups was significantly increased compared to HFD. The expression of PGC-1α and UPC-1 in HFDTCap was also significantly increased compared to HFDT (Respectively P=0.039, P=0.017) and HFDCap (Respectively P=0.046, P=0.001) groups (Table 1).

4. Discussion

In the present study, it was shown that HFD significantly reduced the expression of PGC-1α and UCP-1 in visceral adipose tissue. In this regard, Kwon et al. (2020) showed that HFD reduces the expression of UCP-1 and irisin in visceral adipose tissue and PGC-1α in skeletal muscle of obese mice [26]. Disorders of metabolism due to consumption of high-fat diet appear to reduce the expression of PGC-1α and UCP-1 in visceral adipose tissue. However, in the present study, eight weeks of progressive exercise was able to offset the negative effect of obesity on PGC-1α and UCP-1 expression. In line with this study, Ziegler et al. (2019) in a study showed that both aerobic and resistance training increase the expression of PGC-1α and UCP-1 visceral adipose tissue in rats [34]. Aerobic exercise activates adenosine monophosphate and calmodulin-dependent kinase enzymes using calcium and phosphate-dependent pathways, thereby activating PGC-1α [38]. Exercise has also been reported to increase PGC-1α expression [37], which stimulates UCP-1 expression [43]. Another result of the present study was the increased expression of PGC-

Table 1. Results related to research variables

Variables	Relative Expression PGC-1α	Relative Expression UPC-1
ND	2.852±0.60	9.06±2.08
HFD	1±0.1$^{\#}$	1±0.16$^{\$}$
HFDT	1.878±061$^{\#\$\pm}$	4.142±1.25$^{\#\$\pm}$
HFDCap	1.897±0.66$^{\#\$\pm}$	3.390±1.63$^{\#\$\pm}$
HFDTCap	2.732±0.83$^{\$}$	6.873±2.62$^{\$}$
SIG between groups	0.000	0.000

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* Group bin difference; $^{\#}$ Difference with ND; $^{\$}$ Difference with HFD group; $^{\pm}$ Difference with HFDTCap group

1α and UCP-1 visceral adipose tissue in HFD mice after capsaicin. The findings of the present study are consistent with the finding that capsaicin is able to increase the expression of PGC-1α [20]. In addition, capsaicin is capable of enhancing several metabolic exothermic genes, including UCP-1, BMP8b, SIRT1, PGC-1α, and PRDM-16 [47]. In the present study, the additive effect of the combination of exercise and capsaicin on the expression of PGC-1α and UCP-1 was greater than the effect of each alone. Aerobic exercise and capsaicin appear to increase irisin by affecting the SIRT1/AMPK/PGC-1α signaling pathway, and increasing irisin increases UCP-1 expression in visceral adipose tissue, thereby altering WAT to brown adipose tissue.

5. Conclusion

In summary, exercise and capsaicin affected the browning of visceral adipose tissue in rats, in part due to increased expression of GC-1α and UCP-1. Therefore, the use of capsaicin and other biologically active compounds along with aerobic physical activity is an interesting effective strategy to neutralize high-fat diets.

Ethical Considerations

Compliance with ethical guidelines

This research has been carried out according to the policies related to animal protection (based on the policies of the Helsinki Convention) and with the approval of the Ethics committee in the research of the Institute of Physical Education and Sport Sciences (Code: IR.SSRC.REC.1398.125).

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Authors' contributions

All authors contributed equally in all areas.

Conflicts of interest

The authors declare no conflict of interest.

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