



Exercise Biochemistry Review

Proceedings of IBEC 2018, Beijing, China, October 23-25
PO-248

The Effects of 8-week Swimming Exercise at Different Loads on the Adipose Tissue Androgen Aromatization in Male Obese Mice

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Objective The study takes the aromatization of adipose tissue as the breakthrough point to probe the molecular mechanism of male sex hormone disorder produced by obesity and the effect and mechanism of different exercise loads in alleviating the male sex hormone disorder. The research aims to provide the experimental basis for investigating the mechanism of obesity and exercise produced or improved male sex hormone disorder, and to provide the theoretical basis for exploring the effective exercise load.

Methods A total of forty 3-week-old C57BL/6 male mice were randomly divided into normal control group feeding with normal diet and obesity model group feeding with high fat diet, ten mice for normal control group and thirty mice for obesity model group. We got rid of one mouse which weight did not reach the standard after 10-week of high fat diet. Obesity model group were randomly divided into obesity control group, moderate-load exercise group and high-load exercise group, nine mice for obesity control group and ten mice for moderate-load exercise group and high-load exercise group feeding with high fat diet. Moderate-load exercise group was assigned to 1time/d, 2h/time, 6d/w non-weight-bearing free swimming. High-load exercise group were assigned to 2times/d, 2h/time, 6d/w non-weight-bearing free swimming. After 8-week swimming training, there was one mouse died in each of the exercise group.

After training, the sperm counts were observed by inverted microscope. The serum luteinizing hormone (LH), Follicle-stimulating hormone (FSH), Testosterone (T) and Estradiol (E_2) were tested with Elisa method. The genetic transcription and protein expression of the interleukin-6 (IL-6), Interleukin-6 Receptor (IL-6R) and aromatase in adipose tissue were detected by Real-time PCR and Western blot.

Results 1. Compared with normal control group, weight, fat weight and body fat rate of mice in the obesity control group were significantly increased ($P < 0.01$, $P < 0.01$, $P < 0.05$); Serum Luteinizing hormone (LH), Follicle-stimulating hormone (FSH), Testosterone (T) in the obesity control group were significantly decreased ($P < 0.05$) and serum estradiol (E_2) was significantly increased ($P < 0.01$); Sperm counts and sperm activity of mice in the obesity control group were significantly decreased ($P < 0.01$); The genetic transcription levels of interleukin-6 (IL-6), Interleukin-6 Receptor (IL-6R) and aromatase in adipose tissue in the obesity control group were significantly increased ($P < 0.01$) and the protein expression were significantly increased ($P < 0.05$, $P < 0.01$, $P < 0.05$). 2. Compared with obesity control group, weight, fat weight and body fat rate of mice in the moderate-load exercise group were significantly decreased ($P < 0.01$, $P < 0.05$, $P < 0.05$); Serum Luteinizing hormone (LH), Follicle-stimulating hormone (FSH), Testosterone (T) in the moderate-load exercise group were significantly increased ($P < 0.01$, $P < 0.01$, $P < 0.05$) and serum Estradiol (E_2) was significantly decreased ($P < 0.01$); Sperm counts and sperm activity of mice in the moderate-load exercise group were significantly increased ($P < 0.01$, $P < 0.05$); The genetic transcription and the protein expression of interleukin-6 (IL-6), Interleukin-6 Receptor (IL-6R) and aromatase in adipose tissue in the moderate-load exercise group were significantly decreased ($P < 0.01$). Compared with obesity control group, weight, fat weight and body fat rate of mice in the high-load exercise group were significantly

decreased ($P < 0.01, P < 0.05, P < 0.05$); Serum luteinizing hormone (LH), Follicle-stimulating hormone (FSH), Testosterone (T) and Estradiol (E_2) in the high-load exercise group have no significant differences ($P > 0.05$); Sperm counts and sperm activity of mice in the high-load exercise group were also have no significant differences ($P > 0.05$); The genetic transcription levels and the protein expression of interleukin-6 (IL-6), Interleukin-6 Receptor (IL-6R) and aromatase in adipose tissue in the high-load exercise group have no significant differences ($P > 0.05$).

3. Compared with moderate-load exercise group, weight, fat weight and body fat rate of mice in the high-load exercise group were significantly decreased ($P < 0.05$); Serum luteinizing hormone (LH), Follicle-stimulating hormone (FSH), Testosterone (T) in the high-load exercise group were significantly decreased ($P < 0.01$) and Serum Estradiol (E_2) have no significant differences ($P > 0.05$); Sperm counts and sperm activity of mice in the high-load exercise group were significantly decreased ($P < 0.01$); The genetic transcription levels of interleukin-6 (IL-6), Interleukin-6 Receptor (IL-6R) and aromatase in adipose tissue in the high-load exercise group were significantly increased ($P < 0.05, P < 0.01, P < 0.01$); The protein expression of Interleukin-6 (IL-6), aromatase in adipose tissue in the high-load exercise group were significantly increased ($P < 0.01$), but Interleukin-6 Receptor have no significant differences ($P > 0.05$).

4. IL-6 correlated positively with aromatase ($r = 0.776, P < 0.01$) and Estradiol (E_2) ($r = 0.414, P < 0.05$) and correlated negatively with Testosterone (T) ($r = -0.572, P < 0.01$); IL-6R correlated positively with aromatase ($r = 0.435, P < 0.01$) and Estradiol (E_2) ($r = 0.486, P < 0.01$) and correlated negatively with Testosterone (T) ($r = -0.321, P > 0.05$); Aromatase correlated negatively with Testosterone (T) ($r = -0.562, P < 0.01$) and positively with Estradiol (E_2) ($r = 0.435, P < 0.01$).

Conclusions 1. Eighteen weeks of high fat diets for male mice led to serious obesity and facilitated the inflammation in adipose tissue. The up-regulation of gene and protein expression of adipose tissue IL-6 stimulated aromatization and prompted testosterone converted into estrogen, leading to sex hormone disorder.

2. Long-term moderate-load exercise reduced the body fat effectively and inhibited the gene and protein expression of adipose tissue IL-6. Meanwhile, it inhibited the aromatization and improved sex hormone disorder associated with obesity.

3. Long-term high-load exercise reduced the body fat significantly, but had no effect on aromatization which was mediated by adipose tissue IL-6, nor relieved male sex hormone disorder associated with obesity.