

## Influence of Training Environment Temperature on Obesity Patients Trying to Lose Weight

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**Keywords:** Surrounding temperature; Obesity; Aerobic gymnastic exercise; Body fat; Therapeutic effect

**Abstract:** Objective: To observe the weight reducing effect at different temperatures on obesity patients by doing aerobics. Method: randomly divide 100 obese adolescents into low temperature group, medium-low temperature group, medium temperature group, medium-high temperature group and high temperature group and give them the same aerobic gymnastic training respectively under the following ranges of temperatures: 16~20°C, 21~25°C, 26~30°C, 31~35°C, 36~38°C, and assess the change of their body fat before the training and 24 weeks after the training respectively. Result: after 24 weeks of exercise, the improvement rates of the body fat of the low temperature group (LTG), medium-low temperature group (MLTG), medium temperature group (MTG), medium-high temperature group (MHTG) and high temperature group (HTG) are 5.6%, 7.0%, 11.6%, 16.7% and 22.6% respectively; Patients' appetite decreases noticeably as the training temperature rises; and the statistical analysis shows that the improvement rate of the body fat of the high temperature group is obvious higher than those of other groups ( $P < 0.05$  or  $P < 0.01$ ). Conclusion: For obesity patients doing aerobics in 16 to 38°C, as the training temperature rises, their weight can be reduced more remarkably. In the 4 aerobic weeks, lower temperature enhances their appetite, whereas higher temperature represses their appetite.

### 1. Introduction

With the increase of the present living standard and the pressure at school, there is a tendency of sharp increase in the number of obese adolescents. Obesity not only affects the body shape of the people, but causes such diseases as diabetes, hyperlipidemia, high blood pressure, fatty liver, arteriosclerosis, and myocardial infarction which threaten the life and health of the people [1-3]. Weight reduction by exercise has aerobic endurance exercise as its core, for example, bikram yoga, one of the representatives of aerobic exercise, is very popular among the obese patients [4, 5]. Originated in Thailand, bikram yoga aerobic exercise poses express requirement for surrounding temperatures (close to 40°C), i.e, in such exercise, it is believed that ideal effect on weight reduction can be achieved under high temperature [6]. Given that there are few international studies on the effect on weight reduction of obese adolescents through aerobic gymnastic exercise under different temperatures, this study, with reference to yoga exercise, designs a set of gymnastic exercise to observe the experimental effect on weight reduction of obese adolescents through aerobic gymnastic exercise under different temperatures and is hereby reported as follows:

## 2. Objects and Method

### 2.1 Objects of Study.

By reference to the classification of overweight and obese patients formulated by WGO, this research chose 100 overweight young students at higher schools, of which there are 65 male students with an average age of 20.26 and 35 female students with an average age of 19.65; All the experimental objects are aware of and willing to accept the experiment and have no such diseases as respiratory diseases, serious cardia-cerebrovascular diseases, kidney diseases or dyskinesia. The said selected objects are randomly divided into 5 groups with each group consisting of 20 patients. See Table 1 for the general data of the 5 groups of patients, the statistical analysis shows that the difference has no statistical significance ( $P > 0.05$ ) but have comparability.

Table 1 Comparison of Main Physical Indexes of the Objects of the Five Groups ( $\bar{x} \pm s$ )

Group	Number (Male/ Female)	Height (cm)	Weight (kg)	Age (years)	Upper arm sebum (mm)	Shoulder sebum (mm)	Thigh sebum (mm)	Abdominal fat (mm)	Body fat Percentage (%)
LTG	20 (13/7)	165.3±2.7	76.2±3.6	20.2±1.31	28.1±5.14	32.3±5.20	34.9±3.20	36.1±5.34	31.6±2.31
MLTG	20 (13/7)	166.7±2.7	77.3±3.6	20.2±1.28	27.6±5.16	32.0±5.12	34.6±3.17	35.2±5.26	30.3±2.27
MTG	20 (13/7)	166.3±2.3	76.1±3.9	19.2±1.30	27.3±4.97	30.8±4.99	33.6±3.14	34.8±5.31	29.6±2.34
MHTG	20 (13/7)	164.2±2.4	75.6±3.7	19.1±1.52	28.3±5.15	32.5±5.18	34.8±3.12	36.6±5.38	31.2±2.32
HTG	20 (13/7)	165.9±2.8	77.2±3.3	20.8±1.46	28.3±4.86	32.3±4.92	33.9±2.96	36.9±5.02	31.8±2.29

Note: after comparison of the main physical indexes of the five groups, it is discovered that the inter-group difference has no statistical significance ( $P > 0.05$ ).

### 2.2 Therapeutic Method.

The low temperature group, medium-low temperature group, medium temperature group, medium-high temperature group and high temperature group respectively have the same aerobic gymnastic exercise under the guidance of the coaches previously uniformly trained in the room with the following ranges of temperatures: 16~20°C, 21~25°C, 26~30°C, 31~35°C, 36~38°C. The aerobic gymnastic exercise consists of the preparatory and basic activities and the basic activities contain the following twelve continuous acts: (1) standing straight, exhaling, hands clasped before the chest; (2) standing straight, exhaling, arms stretched upward along the ears, upper body leaning back, hip leaning forward and arm keeping stretched along the ears; (3) standing straight, inhaling, body bent forward, hands flatly on the ground with fingers and toes at the same level, and keeping heads to the knees as close as possible; (4) ground holds, exhaling, stretch the right leg as hard as possible with the right knee touching the ground (use the other leg in the next round of exercise); (5) front lunge, holding breath, stretch the left leg straight backward, in a push-up posture; (6) front support, exhaling, knee joints bent, the knees, chest and lower jaw touching the ground; (7) kneeling, inhaling, hips forward, head leaning backward, chest expanding, in a posture of cobra; (8) lying prostrate, exhaling, hands and legs motionless, hip moving upward, in the posture of an upside-down "V"; (9) ground holds, inhaling, right leg between two arms, left leg touching the ground (use the other leg in the next round of exercise), looking upward; (10) standing straight, exhaling, left leg stretched forward with straight joints, forehead close to the knee; (11) standing straight, inhaling, arms upward stretching straight, body stretching backward as practically possible; (12) exhaling, restoring to standing posture, feet together, hands at two sides. After the said continuous acts are finished, repeat them after inhaling deeply. The exercise lasts 50-60 minutes each time and is done four times a week and the total period for such exercise is 24 weeks. All the objects do the exercise in strict accordance with the instruction of the coaches and no one quits such exercise.

### 2.3 Evaluation Standard for Therapeutic Effect.

Detection of the body fat of all the groups are made before the training and 24 weeks after the training respectively by using the Inbody 3.0-mode physical ingredients analyzer produced by the Republic of Korea, to compare and analyze the fat improvement rate of each group. Fat improvement rate = [(pre-treatment average fat content-after-treatment average fat content)/pre-treatment average fat content] X100%. The higher the rate is, the more conspicuous the effect on weight reduction of the experimental objects.

Research was done after one week and four weeks respectively to find out changes in appetite by way of interview. Patients are required to report their recent amount of food intake and how much they want to eat food in order to decide on the differences before and after their training. There were three choices marked better, worse or unchanged.

### 2.4 Statistical Analysis.

The data will be processed using SPSS 13.0 and expressed in ( $\bar{x} \pm s$ ). The pre-treatment and after-treatment internal data of each group will be compared and the inter-group improvement effect after treatment will be compared as well using variance analysis. After variance analysis, if the difference among the data of the groups has statistical significance, it only means the general averages among the groups are different or are not identical. If you wish for more understanding of the general averages between two groups, you should make a pairwise comparison of all the data which is also called multiple comparisons. This article adopts Dunnett-t detection which is applicable to the comparison between several control groups and one experimental group. So, Dunnett-t detection is used in pairwise comparisons, and  $P < 0.05$  means the difference has statistical significance.

## 3. Result

### 3.1 Comparison in Body Fat Improvement.

The details of the fat improvement of the objects of the five groups after 24 weeks of training can be seen in Table 2. The data in Table 2 show that, with the progressive increase of the temperature of the surrounding during the exercise, the fat improvement rate gradually increases and the fat improvement rate of the high temperature group is obviously higher than those of the four other groups, and the inter-group difference has statistical significance ( $P < 0.05$  or  $P < 0.01$ ); the fat improvement rate of the medium-high temperature group is also evidently higher than those of the low temperature and the medium-low temperature groups, and the inter-group difference has statistical significance ( $P < 0.05$ ).

Table 2 Analysis of the body fat changes before and after training ( $\bar{x} \pm s$ )

Group	Number (Male/Female)	BT Fat Percentage (%)	AT Fat percentage (%)	Fat Improvement Rate (%)
LTG	20 (13/7)	31.6±2.31	29.8±2.26	5.6±2.29bc
MLTG	20 (13/7)	30.3±2.27	28.2±2.18	7.0±2.24bc
MTG	20 (13/7)	29.6±2.34	26.1±2.31	11.6±2.32a
MHTG	20 (13/7)	31.2±2.32	25.9±2.30	16.7±2.31b
HTG	20 (13/7)	31.8±2.29	24.6±2.24	22.6±2.27

Note: compared with HTG, aP < 0.05, bP < 0.01; compared with MHTG, cP < 0.05 (BT-Before Training, AT = After Training).

### 3.2 Comparison in Appetite.

Vestigation was done after one week and four weeks of training respectively. After one week, LTG, MLTG and MTG do not undergo remarkable changes compared with pre-training, whereas

MHTG and HTG fare worse in their appetite. After 4 weeks of training, changes became much clearer with every group, that is, as temperature rise, appetite drops. HTG's appetite became the worst and their rate of becoming better is low. On the other hand, LTG's rate of becoming better is high. In conclusion, aerobics in lower temperature improves one's appetite while higher temperature inhibits one's appetite. See table 3.

Table 3 Comparison on appetite before training, one week and four weeks after training ( $\bar{x} \pm s$ )

Group	Number (Male/ Female)	after 1 week (Number,%)			after 4 weeks (Number,%)		
		better	worse	unchanged	better	worse	nchanged
LTG	20 (13/7)	3, 15.00	0, 0.00	17, 85.00	15, 75.00	3, 15.00	2, 10.00
MLTG	20 (13/7)	4, 20.00	0, 0.00	16, 80.00	15, 75.00	3, 15.00	2, 10.00
MTG	20 (13/7)	3, 15.00	1, 5.00	16, 80.00	10, 50.00	6, 30.00	4, 20.00
MHTG	20 (13/7)	2, 10.00	5, 25.00	13, 65.00	4, 20.00	14, 70.00	2, 10.00
HTG	20 (13/7)	3, 15.00	7, 35.00	12, 60.00	2, 10.00	17, 85.00	1, 5.00

#### 4. Discussion

Insufficient energy consumption and defect in energy metabolism may be the basis for appearance and continuance of obesity, so, the main reason for the obesity of adolescents may be their excessive nutrition, excess intake of thermal energy and gradually decrease of metabolism for lack of physical exercise for a long time [7, 8]. In course of weight reduction through aerobic exercise, aerobic exercise can not only reduce the volume of fat cells, but reduce the feeding efficiency and increase the metabolic rate by increasing the energy consumption, whereby is able to reduce the fat accumulation to the greatest extent [9-11]. This study, by observing the effect on weight reduction of obese patients through aerobic gymnastic exercise under different temperatures, finds that, aerobic exercises like yoga can reduce weight of the obese patient, but their effect is not obvious in surroundings of 20°C and the effect on weight reduction increases with the increase of the surrounding temperature. The best effect of weight reduction is achieved in surroundings of over 35°C, at which, the fat improvement rate of the patients reaches its peak, implying that the effect of aerobic exercise under high temperature on weight reduction is comparatively better. But as humane body has a endurance limit of temperature. Excessively high temperature not only causes heat stroke, but imposes great physical and mental burden on the patients, which will in turn reduce the effectiveness of aerobic exercise, so, the temperature should not be so high. The temperature fixed for the high temperature group in this study is 36~38°C, close to the humane body temperature.

The mechanism in which aerobic gymnastic exercise in hot surroundings can reduce the fat of the obese patients includes the following: (1) in exercise in hot surrounding, it is hard for heat generated inside humane body to diffuse, which increases the body temperature. According to recent studies, increase of body temperature will enhance energy metabolism. For example, aerobic exercise under high temperature of about 37°C can increase the energy consumption by 10%-40% [12, 13]; (2) under heat stress, sympathetic nerves are excited, while parasympathetic nerves is suppressed and the functions of the digestive system reduced, causing low energy intake and relative increase of energy consumption. Thus, the negative balance between calories intake and consumption is created, which can produce the effect of fat consumption, weight reduction and fitness [14, 15]; (3) the aerobic endurance exercise in hot surrounding can quickly increase the body temperature, blood circulation, excitability of sympathetic nerves, activity of catecholamine, level and activity of the Lipid oxidase, accelerate the decomposition of chylus and low-density lipoprotein consisting of rich triglyceride, enhance the high-density lipoprotein, and ultimately speed up the free fatty acid [16, 17]; (4) other studies show that, in course of aerobic exercise, insulin secretion is reduced which reduces the antilipolytic effect of plasma insulin and increase the function of fat decomposition [18, 19]. From the perspective of change of appetites of the groups, we can that, after the training for one to four weeks, with the continuance of the training, the

appetite of the low-temperature group was obviously improve, which signified the well-recognized idea that aerobic fitness exercise could improve the state of mind and the appetite of the trainees; while the appetite of the high-temperature group was evidently suppressed. This was because that the sympathetic nerves of the high-temperature group were excited while their parasympathetic nerves were suppressed under the heat stress state, which reduced the functions of their digestive system and their nutrients absorption, therefore causing their sense of hunger to be reduced as well.

In summary, this study indicates that, if the obese adolescents are given aerobic exercise in the surrounding at a degree ranging from 16°C to 38 °C, the effect of such exercise on their weight reduction will be increased with the increase of the temperature of the surrounding, in particular, aerobic fitness exercise in high temperature (36 °C~38 °C) can be increase the body temperature of the trainees while suppressing their appetite at the same time. Meanwhile, such exercise can also accelerate the blood circulation and promote the lipid metabolism and therefore is conducive to weight reduction. Considering the endurance limit of obese patients to high temperature and the acceptability of aerobic exercise under high temperature, the maximum temperature in this study does not exceed 38°C, nor will this article recommend aerobic exercise under high temperature of over 38°C. It may be worthy of further efforts to explore and discuss whether the effect of aerobic exercise is better or not at a certain point of temperature over 38°C.

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