The effect of aerobic training with two different intensities on body composition, aerobic capacity, and salivary hormones of overweight men

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Abstract:

Introduction: The main aim of this study was to investigate the effect of aerobic exercise with two different intensities on body composition, aerobic capacity, and salivary hormones of overweight men.

Materials and Methods: 35 overweight male volunteers (mean age 31.3 ± 3.3 years, height 170.5 ± 4, weight 77.42 ± 6.2) were randomly divided into three groups of high-intensity aerobic exercise (HIAT, 12 people) and low-intensity exercise. (LIAT, n=12) and control group (CG, n=11). Body composition (WHR, BMI, fat percentage, lean body mass), VO2 max, salivary cortisol, testosterone, and lactate dehydrogenase were evaluated before and after the 8-week training program. Paired t-test and ANOVA were used for statistical analysis ($P<0.05$).

Results: The results of this study showed that high-intensity aerobic training significantly decreased weight, BMI, and fat percentage and increased cortisol and lactate dehydrogenase hormones in this training group. Low-intensity aerobic exercise led to an increase in testosterone ($P<0.05$).

Conclusion: The results of our research revealed that high-intensity aerobic exercise induces weight loss, enhances body composition, and elevates cortisol and lactate dehydrogenase hormones in overweight men. while low-intensity aerobic exercise increases testosterone levels.

Keywords: aerobic exercise, salivary, body composition, lactate dehydrogenase, cortisol

1. Introduction

Exercise is a powerful stimulant for the endocrine system (1). Various training methods, including endurance, resistance, and interval training, can cause different hormonal responses based on their intensity, volume, and duration (2). Aerobic exercises are closely related to hormonal changes and can have other effects on the secretion of hormones in men.

The physiological process of fat loss occurs when fats are released from fat cells into the bloodstream to provide energy (3). Recent research has shed light on the inefficacy of glycogenolysis and the reduced activity of the phosphofructokinase enzyme in adults (4). These findings suggest that alternative methods may need to be explored for energy production in certain situations. Regular aerobic or muscle-strengthening training results in many adaptations in multiple body systems (5). These findings suggest regular aerobic exercise significantly reduces waist circumference and associated visceral adipose tissue. Engaging in regular aerobic physical activities is an effective way to prevent diseases related to being overweight or obese (6). One of the ways to prevent disorders related to obesity and overweight is to use aerobic physical activities. Some scientific evidence shows that aerobic exercises cause changes in body composition and aerobic capacity (7).

Also, recent research has shown that the behavior and secretion of body hormones may differ according to the intensity of the exercises, the body composition of people, and gender differences (8, ()9). Cortisol is an essential hormone regulating stress responses, metabolism, and immune system activity. The saliva cortisol levels can provide accurate information about the unbound cortisol levels (10). The ratio of testosterone to cortisol (fr-T/C) fraction is vital for detecting overtraining in athletes. A decline of over 30% in the balance is a clear sign of overtraining. Research suggests that maximum aerobic training increases testosterone levels while negatively impacting cortisol levels. Differences in how individuals respond to exercise may account for variations in adrenal hormone levels. In response to activity, testosterone promotes skeletal muscle growth (10, ()11). Cortisol and testosterone can be mentioned among these hormones (12). Like cortisol, testosterone increases in response to exercise once a specific intensity threshold is reached. Peak concentrations usually occur at the end of the exercise (13). Investigations showed that the enzyme Lactate Dehydrogenase (LDH) can increase its production due to sports activities, so this enzyme, in addition to being active in the process of producing energy and lactate, also plays an influential role in creating inflammatory conditions for muscle cells (14-16). In their research, Monazzami et al. (2023) stated that sports training with increasing intensity can increase the level of LDH in athletes (17). Therefore, some researchers have reported increased LDH levels due to physical activities caused by muscle fiber membrane damage (18, ()19).

Some studies consider the cause of these changes to be the amount of cortisol production, which stimulates the hypothalamus-pituitary-adrenal axis and increases ACTH secretion (11). In addition, in other research, stimulation of the sympathetic system is considered to cause these changes (20, ()21); despite various research in this field, researchers have not yet reached a consensus.

Among the physiological indicators, the ratio of testosterone to cortisol, which expresses the balance of the process of anabolic and catabolic states in a training period, has been used. The response mechanism of this ratio to training, increase or decrease, has not been reported (22). Studies have shown that hormonal changes that increase testosterone levels and decrease cortisol levels are observed following rhythmic exercise training, which indicates an anabolic process (23). As it seems in another study, an increase in cortisol levels and a decrease in testosterone can intensify the catabolic environment at the tissue level and, as a result, reduce muscle strength and overall performance (24). In the meantime, research focusing on the effects of aerobic exercises with different intensities on the mentioned indicators is less visible. The few studies in this field have less opinion on overweight men (9, ()10). Therefore, observing the contradictions in the findings obtained from the current surveys and studies and the importance of addressing the health issues of people exposed to obesity in the country can be a reason for conducting more research in this field.

2. Material & Methods

Subjects

The research was semi-experimental with a sample size of 163 overweight men between 20 and 40 years old living in Lahijan City. Inclusion criteria included a BMI between 25 to 29.9, no history of skeletal, liver, or blood diseases, a regular sleep cycle, refusal to smoke and drink alcohol, and no prior history of exercise training In the last six months. Thirty-five eligible participants were divided randomly into three equal groups: two groups of 12 people and one group of 11. The Ethics Committee of Islamic Azad University of Rasht, Iran, approved the study under the ethics approval code of IR.IAU.RASHT.REC.1395.63.

Aerobic training program

During an 8-week aerobic program, participants in the HILT and HIAT groups exercised at 45-60% and 70-85% of their reserve heart rate, respectively. The CG did not participate in any exercise training program during this period. The program consisted of 3 training sessions per week. The workout began with a 20-minute warm-up that included jogging, stretching, and relaxation exercises, followed by interval running at 40 to 50% maximum heart rate intensity for each group. The initial running time was 15 minutes, increasing to 40 minutes by the final session. Rest periods between intervals were half the duration of each run, and heart rate was continuously monitored to maintain the desired range. Finally, each session ended with a 10-minute cool-down, including jogging, stretching, and relaxation exercises (25). HR was measured every 5 s throughout the training sessions as an objective measure of exercise intensity. HR data are expressed both as percentage of HRmax (%HRmax) and HRreserve (%HRreserve). The average HR (HRmean) for each training session was calculated. The %HRmax for each form of training was calculated by the following formula: HRmax = HRmean/ HRmax*100.

Measurements

The research entailed administering a Rockport test to evaluate aerobic fitness and conducting body composition and anthropometric tests, both before and after the training program. Furthermore, laboratory samples were taken before and after the exercise program to measure the subjects' salivary cortisol and lactate dehydrogenase levels, with residual activity recorded on the bike.

Biochemical analyses

As part of the research into salivary changes, subjects provided saliva samples at two intervals: 10 minutes before and 10 minutes after training. Before the activity, each subject consumed 200 ml of water to prevent dehydration and rinsed their mouth after a brief period. Then, they provided 6 ml of unstimulated saliva in specialized tubes. After the activity, saliva samples were collected in the same manner 10 minutes later.

The cortisol and testosterone levels in saliva were measured using the ELISA method and kits provided by Diametra, Italy. The test's sensitivity was 3.5 pg/ml with 95% confidence for testosterone and 0.05 ng/ml with 95% confidence for cortisol.

All samples were stored at a temperature of -20 C until the appropriate time for testing. Given the circadian rhythm of cortisol secretion, saliva samples were collected explicitly between 8 and 10:30 a.m. After completing the training period on the day of the experiment, the models were allowed to reach room temperature before analysis to prevent the influence of environmental factors. To eliminate potential confounding effects, all subjects were sampled under identical conditions (26). Additionally, the same method and kit were employed to test all samples. LDH enzyme activity was measured using Pars Azmoun kits and an autoanalyzer machine, Hitachi Roche, manufactured in Germany, utilizing the enzymatic kinetic method.

Statistical analysis

The results were expressed as mean ± standard deviation, and the Kolmogorov-Smirnov test was used to evaluate the normal distribution of the variables. One-way analysis of variance, Tukey, and correlated t-tests were used to compare blood samples in different sports programs, and if necessary, Tukey's post hoc test was used. Statistical evaluation was done with SPSS 26 for Windows, and the significance level of the study was determined as $P < 0.05$.

3. Results

It seems that based on the average results of descriptive statistics and correlated t-test ($p = 0.001$), BMI 24.90 ± 3.24, body fat percentage ($p = 0.012$) 18.27 ± 3.65, cortisol salivary 12.87 ± 2.5 ($p = 0.008$) 0) and salivary lactate dehydrogenase 134.33 ± 21 ($p = 0.001$) in the high-intensity training group and salivary testosterone 14.17 ± 2.07 ($p = 0.001$) in the low-intensity training group had significant differences compared to before the start of training. You can find the statistical results of the correlated t-test in Table 1.

Table 1. descriptive statistics of the research (n=35) Aerobic exercise (high intensity)(n=12), Aerobic exercise (low intensity)(n=12), Control(n=11)

Variable	group	pre-test	post-test	significant
height (cm)	Aerobic exercise (high intensity)	169.30 ± 4.73	-	-
	Aerobic exercise (low intensity)	171.23 ± 5.53	-	-
	Control	170.15 ± 6.05	-	-
age (years)	Aerobic exercise (high intensity)	33.40 ± 3.17	-	-
	Aerobic exercise (low intensity)	31.1 ± 2.72	-	-
	Control	29.64 ± 4.66	-	-
Weight (kg)	Aerobic exercise (high intensity)	75.88 ± 9.84	71.38 ± 9.77	
	Aerobic exercise (low intensity)	78.14 ± 8.07	76.86 ± 7.46	
	Control	78.2 ± 9.66	78.95 ± 9.58	

BMI (kilograms per square meter)	Aerobic exercise (high intensity)	26.47 ± 3.34	24.90 ± 3.24	0.001*
	Aerobic exercise (low intensity)	26.65 ± 2.75	26.21 ± 2.58	0.057
	Control	27.01 ± 3.3	27.27 ± 3.35	0/112
Body Fat (percentage)	Aerobic exercise (high intensity)	20.57 ± 3.73	18.27 ± 3.65	0.012*
	Aerobic exercise (low intensity)	21.83 ± 2.71	20.17 ± 2.54	0.057
	Control	19.4 ± 3.25	19.82 ± 3.19	0.112
Fat Free Mass (kg)	Aerobic exercise (high intensity)	60.27 ± 8.00	58.33 ± 8.56	0.112
	Aerobic exercise (low intensity)	61.08 ± 5.02	61.35 ± 5.43	0.057
	Control	63.02 ± 5.96	63.30 ± 5.76	0.112
WHR (cm)	Aerobic exercise (high intensity)	0.97 ± 0.06	0.95 ± 0.06	0.063
	Aerobic exercise (low intensity)	0.94 ± 0.049	0.93 ± 0.04	0.075
	Control	0.97 ± 0.057	0.98 ± 0.08	0.111
Vo2max (ml/kg)	Aerobic exercise (high intensity)	33.31 ± 8.75	35.91 ± 10.83	0.058
	Aerobic exercise (low intensity)	36.54 ± 5.67	37.09 ± 5.57	0.063
	Control	34.42 ± 4.71	34.34 ± 4.19	0.648
Cortisol (ng/ml)	Aerobic exercise (high intensity)	9.51 ± 1.96	12.87 ± 2.5	0.008*

	Aerobic exercise (low intensity)	8.01 ± 2.12	2.09 ± 8.06	0.131
	Control	8.10 ± 2	8.09 ± 2.05	0.92
Testosterone (ng/ml)	Aerobic exercise (high intensity)	6.96 ± 2.10	7.75 ± 1.53	0.065
	Aerobic exercise (low intensity)	7.42 ± 1.86	14.17 ± 2.07	0.001*
	Control	8.31 ± 1.63	8.42 ± 2.02	0.086
Lactate dehydrogenase (micrometer)	Aerobic exercise (high intensity)	120.19 ± 19.58	134.33 ± 21	0.001*
	Aerobic exercise (low intensity)	130.17 ± 20.01	126.35 ± 35.16	0.066
	Control	112.72 ± 26.6	119 ± 19.84	0.071

*significance at the level of P<0.05

One-way analysis of variance for inter-group changes showed that body fat percentage (P = 0.025), BMI(P = 0.001), cortisol (P=0.002), testosterone (P = 0.001), and lactate dehydrogenase (P = 0.001) had a significant difference. Table 2 displays the outcomes of the one-way analysis of variance, which indicates notable variations in different types within the groups. Tukey's post hoc test to determine the significance level of the variables showed that fat percentage with high intensity (P = 0.001) and low intensity (P = 0.004), BMI with high intensity (P = 0.001) and intensity low (P = 0.001), cortisol with high intensity (P = 0.001) and low intensity (P = 0.001) and testosterone with high intensity (P = 0.009) and low intensity (P = 0.001) is significant.

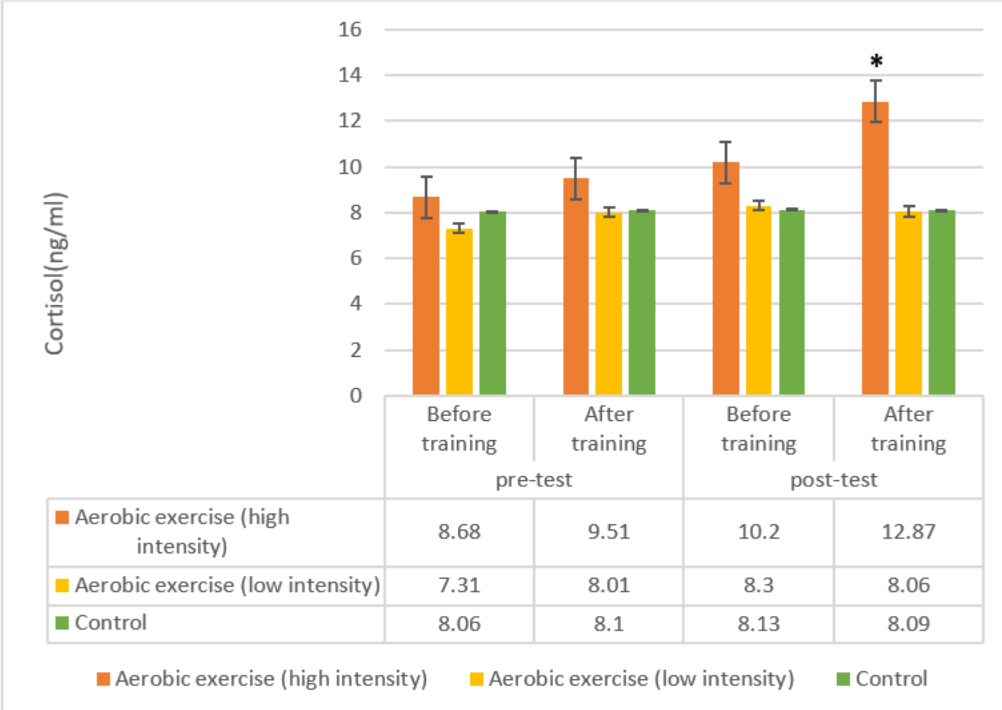
Table 2. One-way analysis of variance test results

variable	Sources Change	The square of the means	degrees of freedom (df)	F	significant	Result
Body fat percentage	intergroup	84.67	2	4.83	*0.025	meaningful
	within the group	280.47	32			

Fat Free Mass (kg)	intergroup	193.28	2	0.68	0.141	non-meaningful
	within the group	4510.47	32			
Body mass index(kg/m²)	intergroup	861.02	2	4.28	0.001*	meaningful
	within the group	3215.51	32			
Waist hip ratio(cm)	intergroup	218.99	2	1.26	0.077	non-meaningful
	within the group	2768.11	32			
Salivary cortisol (end of exercise)	intergroup	2.08	2	6.93	0.002*	meaningful
	within the group	4.86	32			
Salivary testosterone (end of training course)	intergroup	1.09	2	3.60	0.001*	meaningful
	within the group	4.86	32			
Salivary lactate dehydrogenase (end of training)	intergroup	4598.001	2	11.57	0.001*	meaningful
	within the group	6354.56	32			

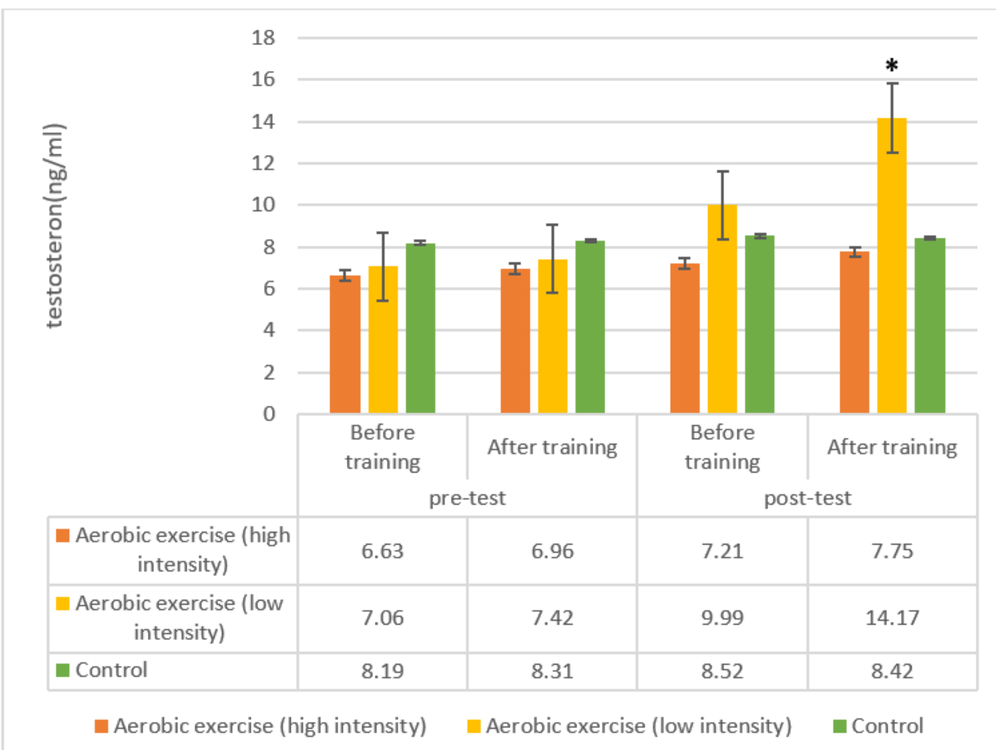
*significance at the level of $P<0.05$

The results of the one-way variance analysis are presented, indicating a significant difference in the mentioned variables in the groups.



	pre-test		post-test	
	Before training	After training	Before training	After training
Aerobic exercise (high intensity)	8.68	9.51	10.2	12.87
Aerobic exercise (low intensity)	7.31	8.01	8.3	8.06
Control	8.06	8.1	8.13	8.09

Figure 1. The effect of high-intensity aerobic exercise on salivary cortisol levels. Values are mean (±SD).



	pre-test		post-test	
	Before training	After training	Before training	After training
Aerobic exercise (high intensity)	6.63	6.96	7.21	7.75
Aerobic exercise (low intensity)	7.06	7.42	9.99	14.17
Control	8.19	8.31	8.52	8.42

Figure 2. The effect of high-intensity aerobic exercise on salivary lactate dehydrogenase. Values are mean (±SD).

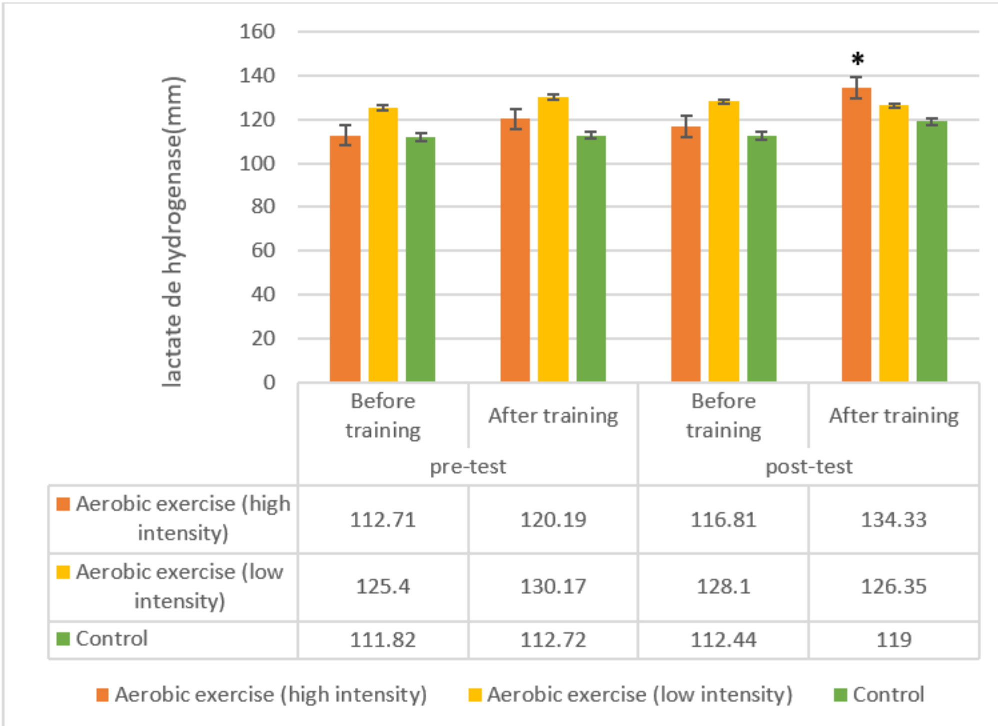


Figure 3. The effect of low-intensity aerobic exercise on salivary testosterone levels. Values are mean (±SD).

4. Discussion

This study aimed to determine the effect of aerobic training with two different intensities on overweight men's body composition, aerobic capacity, and salivary hormones. The results of this study revealed a notable increase in indicators of body composition, cortisol, and lactate dehydrogenase following eight weeks of high-intensity aerobic training compared to pre-test data. However, no significant differences were observed in testosterone and power aerobics. Conversely, a substantial increase in testosterone was observed following eight weeks of low-intensity aerobic training, but no significant changes were seen in cortisol and lactate dehydrogenase levels.

Engaging in physical exercise activates the hypothalamic-pituitary-adrenal (HPA) axis, increasing cortisol levels. However, the response of the HPA axis to exercise can differ depending on the duration and intensity of the exercise (27). Interestingly, when exercise is performed at similar relative intensities among trained and non-training individuals, the change in cortisol concentration remains independent of their fitness status (1). A single intense 30-minute aerobic exercise session boosts ACTH, cortisol, and cortisone levels until exhaustion in healthy males. The adrenal gland induces cortisol production through an increase in ACTH. However, cortisol is also metabolized rapidly, leading to increased THF levels. THF levels remain elevated 30 minutes after exercise, indicating an increased metabolism and clearance rate (28).

This research aligned study with the investigations of Alizadeh et al. (2017) (7), Barrios et al. (2020), Sarkar et al. (2021), Rahmanian et al. (2022) (14-16), Monazzami et al. (2023) (17), Ahmadi et al. 2021) (23).

Despite conflicting with Piotrowska et al. (2021) (24), Ribeiro et al. (2021) (29), Ribeiro et al. (2021), and Vaamonde et al. (2022), the recent study found (30). The disparity could be due to differences in sampling, work methods, and environmental conditions (8, ()9). Different mechanisms have justified changes in hormones in exercise. Research reported a decrease in testosterone following aerobic exercise, which may be due to an increase in testosterone excretion rather than its metabolism (29). Furthermore, extended training can hinder gonadotropin secretion and decrease salivary testosterone concentration (30). Several studies have looked into total and free testosterone levels to reconcile these discrepancies. The variation in research findings may be due to different testosterone measurement methods (29). In addition, long-term training prevents gonadotropin secretion and decreases salivary testosterone concentration (30). To justify these contradictions, we can point to various studies that have used total testosterone levels. In some studies, free testosterone has also been investigated. It seems that this is one of the reasons for the disagreement in research (31).

Compared to low-intensity aerobic exercise, high-intensity aerobic exercise can yield better results for fat loss and body composition improvements (32). Salivary cortisol, testosterone, and lactate dehydrogenase measurements can be valuable indicators of the effectiveness of high-intensity training (10, ()33). Based on these findings, it may be beneficial to incorporate high-intensity exercise into fitness routines for optimal health outcomes (25). Typically, endurance activities involve activating the aerobic system and the fat metabolism cycle. This ultimately leads to increased fat catabolism, as fat becomes a source of energy rather than being stored in the body (34, ()35). Regular aerobic exercise decreases excess fat accumulation, resulting in a gradual decrease in body fat weight (36). By reducing excess fat, the body mass index (BMI) can improve and maintain a healthy range. Numerous studies have shown that as individuals improve their aerobic fitness, their BMI tends to approach the normal range of 20 to 25, achieved through decreased body fat.

Considering the limitations of the current study, it is recommended to conduct additional research using different exercise durations and intensities to understand the effects of exercise on various variables. Additionally, it is essential to highlight that the long-term effects of aerobic exercise on cortisol metabolism and clearance require further investigation as they have not been fully explored yet.5. Conclusion.

The study suggests that high-intensity aerobic exercise can significantly improve physical well-being. It reduces BMI and body fat and increases cortisol levels and lactate dehydrogenase.

Therefore, adding high-intensity aerobic exercise to one's fitness routine can enhance overall health and wellness.

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