SIN-CHN SCIENTIFIC PRESS PTE.LTD.

Molecular & Cellular Biomechanics 2024, 21, 156.
https://doi.org/10.62617/mcb.v21.156

Article

Evaluation on the effect of different time sports training on anti-oxidation ability and anti-aging

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CITATION

Li W. Evaluation on the effect of different time sports training on anti-oxidation ability and anti-aging. Molecular & Cellular Biomechanics. 2024; 21: 156. https://doi.org/10.62617/mcb.v21.156

ARTICLE INFO

Received: 22 May 2024
Accepted: 15 June 2024
Available online: 4 September 2024

Abstract: It is well known that sports can bring beneficial effects on the human body, and it is always followed by people. However, it is now said that sports training has a certain effect on human anti-oxidation and anti-aging, but there are few sports trainings at different times on the market to combat the effects of oxidation and anti-aging. Based on the above conditions, this paper studied the effects of different times of physical training on anti oxidation ability and anti-aging, and conducted experimental research. Finally, the conclusion was drawn: the effects of different times of physical training on SOD (superoxide dismutase) content in mice was not obvious; the effect of 1 h exercise time on GSH-Px activity was better than that of 0.5 h exercise time and 2 h exercise time; the activity of CAT (catalase) was best enhanced by exercise within 0.5 h; after regular aerobic exercise, the level of free radicals in mice decreased, and antioxidant enzymes played a good role in scavenging free radicals; the content of H_2O_2 in the body of mice decreased to 19.624 nmol/L after 2 h exercise, indicating that regular exercise for a long time can reduce the content of oxygen free radicals in the body and play a positive role in the human body.

Keywords: different time; physical exercise training; antioxidant capacity; anti-aging capacity

1. Introduction

In recent years, people are also more willing to buy anti-oxidation and anti-aging food and use anti-oxidation and anti-aging beauty products in their daily life, but they do not know that regular physical exercise every day can improve the anti-oxidation ability of the human body and bring more possibilities to people's anti-aging [1,2]. In order to make people realize the great benefits that physical exercise can bring to people's bodies and help the public correctly master the anti-oxidation and anti-aging methods, it is necessary to investigate the impact of physical exercise on the anti-oxidation and anti-aging of the public [3].

Antioxidant capacity has aroused heated discussion among scholars in the academic circle, and many scholars have made great achievements in this field. Jang et al. evaluated the association between central health and critical surgical conditions in patients with sepsis and serum oxygen radical activity and total antioxidant capacity [4]. Hadadi et al. determined the antioxidant potential of papaya extract by evaluating its total polyphenol content, total flavone content and determining its antioxidant capacity [5]. Mengjie et al. studied the content of total saponins content in cultured and popular Parisian herbs from south-western China [6]. Zhao et al. evaluated the effect of cyanobacteria in the diet on the growth, body color and antioxidant capacity of carp [7]. Liu et al. evaluated the effects of *Bacillus coagulans* on intestinal morphology, plasma antioxidant capacity, proinflammatory cytokines and colonization of laying hens infected with intestinal salmonella [8]. López Prado et al.

evaluated the total phenolic load, total cyanidin content and oxidative activity of extracts of He Ding Red obtained after 6, 12 and 24 h of immersion in distilled water, methyl alcohol and/or water-methanol (1:1) solvents [9]. Lu found that single doses of mannan oligosaccharides combined with β-glucan or their combination with allium powder improved the stability of growth, resistance to oxidation, non-specific vaccination and disease fighting ability of the Chinese soft-shelled turtle [10]. Many substances have the ability to resist oxidation, which bring great benefits to the human body.

Sports training has been widely studied in society, which has a great impact on public life. Jelii et al. studied prepubertal boys [11]. Wang studied that the wearable devices of the Internet of Things based on energy collection are used to monitor the energy conservation of sports training [12]. Tong proposed an exploratory hybrid structural formula modelling framework for functional training decision making [13]. Liang used multidisciplinary knowledge and various scientific principles as a guide to implement optimal control of the whole process of sports training by using modern technological achievements and scientific training methods and tools [14]. Ren and Li investigated the possibility of combining virtual reality technology with numerous competitive sports [15]. Qian conducted an in-depth analysis and study of intelligent management and monitoring systems for sports training gyms through the Internet of things [16]. Bicer investigated the effects of an eight-week strength training programme supported by functional exercise equipment on the anaerobic and aerobic capacity of male volleyball players [17]. In sports training, many people have carried out research on this, but have not seen the effect of antioxidant capacity and anti-aging.

To enhance public awareness of physical exercise and improve people's physical health, this paper examines the antioxidative capacity and anti-aging effects of sports training at different times. Mice were selected as experimental subjects, with exercise duration as the independent variable and the levels of SOD, GSH-Px, CAT, MDA, and H_2O_2 as dependent variables. This study yields a viable conclusion.

2. Specific evaluation of fuzzy clustering algorithm

The fuzzy clustering algorithm involves the following steps: Firstly, forming a non-cluster set for N pixel samples of the target object, and performing image segmentation using the fuzzy clustering weight factor k, where the image segmentation area $J(U, V)$ is equivalent to the weighted sum of pixel-to-cluster center distances squared; secondly, utilizing a hollow rectangular frame to measure the temporal matrix of the image and simplifying it into a second-order matrix to extract the fuzzy attributes of the temporal difference image; finally, by taking the intersection of accumulated frame differences, effectively concentrating pixels in the changing region around the foreground contour, to obtain the desired motion foreground contour. The purpose of using the fuzzy clustering algorithm is to evaluate the impact of different timing of exercise training on antioxidative capacity and anti-aging effects. The fuzzy clustering algorithm is employed to segment and analyze data, quantifying the impact of exercise training on antioxidative capacity within mice. Through analyzing the clustering segmentation of pixel samples, a more accurate assessment of the influence of exercise training on the biochemical indicators within mice can be achieved, thus providing deeper insights into the mechanisms of different timing of exercise training on antioxidative capacity and anti-aging effects.

When the target object consists of *N* pixel samples, these samples are organized into an unclustered set, represented as:

$$X = \{x_1, x_2, \cdots, x_n\} \tag{1}$$

C represents the number of image segmentation categories, and *k* represents the fuzzy clustering weighting factor. The image segmentation area $J(U, V)$ is numerically equivalent to the weighted sum of the squares of the distance between pixels and the cluster center:

$$J(U,V) = \sum_{k=1}^{N}\sum_{i=1}^{C}(u_i(x_k))^k \, d_{ik}^2 \tag{2}$$

$$U = u_i(x_k) \tag{3}$$

If the time-domain difference image is $d(x, y)$, (x, y) represents pixels, a hollow rectangle with one motion $\eta(x, y)$ to measure the image time domain matrix:

$$m_d^4 = \frac{1}{N_\eta}\sum_{\eta(x,y)} d(x,y) \tag{4}$$

$$\bar{m} = \frac{1}{N_\eta}\sum_{\eta(x,y)} d(x,y) \tag{5}$$

The fourth order matrix is simplified to the second order matrix to extract the fuzzy attributes of the time-domain difference image. The function expression is:

$$m_d^2 = \frac{1}{N_\eta}\sum_{\eta(x,y)} (d(x,y) - \bar{m})^2 \tag{6}$$

$u_{MR}(x, y)$ is the background membership function of fuzzy attributes of sports video images, and $u_{NR}(x, y)$ is the foreground membership function:

$$u_{MR}(x,y) = S(x,y,a,b) = \begin{cases} 0, & 0 \le m_d^2 \\ 1, & m_d^2 > b \\ \dfrac{2m_d^2 - 2a}{b-a}, & a < m_d^2 \le \dfrac{a+b}{2} \\ 1 - \dfrac{2m_d^2 - 2a}{b-a}, & \dfrac{a+b}{2} < m_d^2 \le b \end{cases} \tag{7}$$

$$u_{NR}(x,y) = 1 - u_{MR}(x,y) \tag{8}$$

In the formula: *a* and *b* are the weight parameters of *S* function.

Equation (2) is improved to obtain:

$$J = \sum_{(x,y)} u_{MR}(x,y)\left|m_d^2 - c_{MR}\right|^2 + \sum_{(x,y)} u_{NR}(x,y)\left|m_d^2 - c_{NR}\right|^2 \tag{9}$$

$$c_{MR} = \frac{\sum_{(x,y)} u_{MR}^2(x,y) m_d^2}{\sum_{(x,y)} u_{MR}^2(x,y)} \tag{10}$$

$$c_{NR} = \frac{\sum_{(x,y)} u_{NR}^2(x,y) m_d^2}{\sum_{(x,y)} u_{NR}^2(x,y)} \tag{11}$$

The two types of cumulative results of the first *n* frames are:

$$D_1 = \sum_{k=1}^{n}|f_{k+1}(x,y) - f_k(x,y)| = E \cup N_1 \tag{12}$$

$$D_2 = \sum_{k=1}^{n}|f_{k+2}(x,y) - f_k(x,y)| = F \cup N_2 \tag{13}$$

By taking the intersection of the two types of cumulative frame differences, the pixels belonging to the changing area in both types of cumulative results can be effectively concentrated around the foreground contour to obtain an ideal moving foreground contour.

$$D_1 \cap D_2 = (A \cup N_1) \cap (B \cup N_2) = EF \cup (EN_1 \cup FN_1 \cup N_1N_2) \quad (14)$$

Equation (14) can be rewritten as:

$$D_1 \cap D_2 = AB + N \quad (15)$$

3. Theory and inducement of aging

(1) The theory of aging

The aging process involves multifactorial and complex physiological changes, constituting an inevitable stage of human development [18]. After the age of 30, human organs, cells and physiological functions would decline at different rates with the increase of age. The highest age of human life is 125 years old, but most people can't reach this age because various congenital or acquired factors such as environment, nutrition, disease, psychological and social factors, bad habits, physical activities, etc. accelerate the aging process and increase the incidence of human disease. As the aging process is irreversible, whether to delay aging has become a hot research topic.

With the continuous improvement of social aging, various geriatric diseases are gradually increasing, which brings great inconvenience to people's lives and affects social progress and development [19,20]. Aging is a normal and complex biological process, which mainly refers to the degeneration of various structures and functions of cells, tissues and organs of the body, and is the result of the interaction of various factors. There are many opinions about the aging mechanism, but the widely accepted view is the free radical theory. According to the free radical theory, the metabolism of the human body continuously produces free radicals. At the same time, the free radical scavenging system of the human body also continuously removes free radicals, acidic nucleic acids, proteins and other biological macromolecules release lipids. Peroxidation and some metabolites affect DNA transfer and expression, as well as enzyme activity, leading to cell senescence and apoptosis.

(2) Incentives of aging

Now people know that the inducements of cell senescence mainly include two aspects. Telomere shortening leads to stem cell aging, mitochondrial dysfunction and stem cell aging, as shown in **Figure 1**.

1) Telomere shortening leads to stem cell senescence

The reason for cell senescence is that the ability of cell division is limited. After about 50 divisions, cells can no longer reproduce [21]. Telomeres continue to shorten in the cell proliferation cycle, eventually leading to DNA damage reaction mechanism, and leading to cell cycle stop. Cells with high proliferative capacity, such as stem cells and tumor cells, have higher telomerase activity than normal adult cells, and can maintain telomere length. Telomerase activity can directly affect the function of stem cells, leading to stem cell aging [22,23].

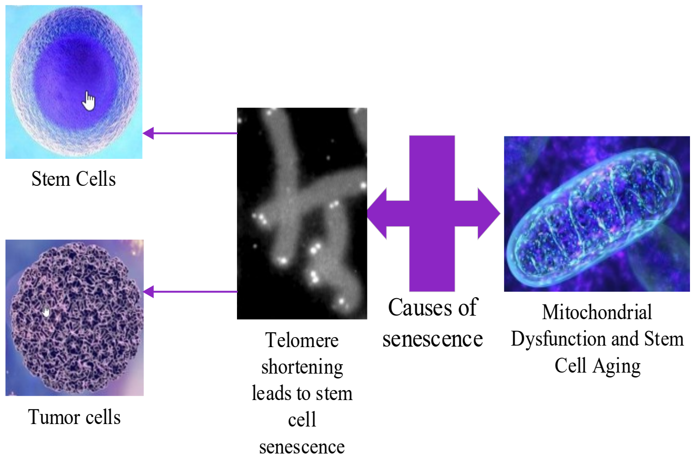

Figure 1. Triggers of senescence.

2) Mitochondrial dysfunction and stem cell aging

Mitochondria are the power source of cells and contain independent genetic material, such as DNA [24]. When mitochondria generate energy during aerobic respiration, they produce oxidative stress products, such as ROS. The continuous accumulation of ROS in cells can lead to the mutation of mitochondrial DNA (mtDNA), which leads to the dysfunction of mitochondrial function and eventually leads to aging, apoptosis or cell death. In mice with mtDNA mutations, hematopoietic cells were damaged during intrauterine development, leading to aging of neural cells, and ultimately damaging the ability of neural cells to self-renew to cope with the accumulation of mtDNA mutations [25,26].

4. Evaluation on sports training

Modern people pay more and more attention to the maintenance of the body, and also pay more attention to the diet in life, in order to achieve the purpose of anti-oxidation and anti-aging. However, people do not realize that exercise is the most effective way to meet the requirements of anti-oxidation and anti-aging, so people need to strengthen physical exercise in life [27,28]. Exercise can bring many positive effects to human body, as shown in **Figure 2**.

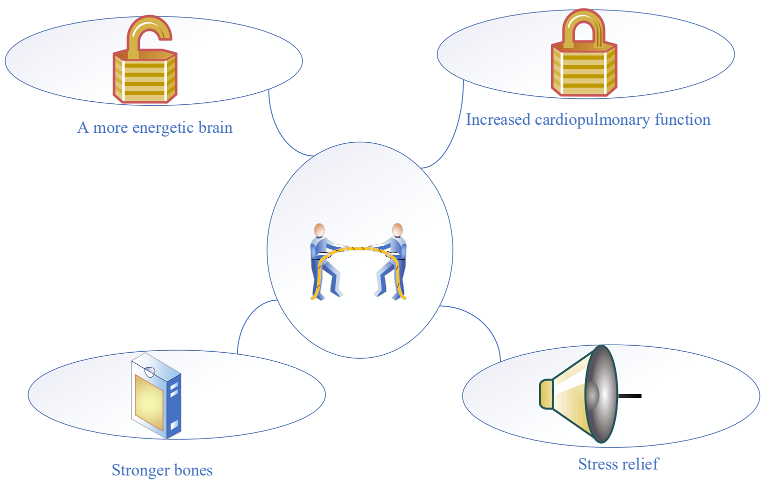

Figure 2. The impact of exercise.

(1) The relationship between sports training and anti-aging

Free radicals are highly oxidizing and can damage many body organs and tissues [29]. They can also react with the bilayer structure of the cell membrane to form lipid peroxides. Malondialdehyde easily combines with protein or lipid to form lipofuscin. As it accumulates with age, it is considered to be a basic feature of cell degradation, because it is not easy to be degraded by lysosomes and accumulates with cell aging. The ability of learning and memory is negatively correlated with the level of lipofuscin in the brain [30,31].

Now many scholars have studied sports and found the relationship between sports training and free radical oxidation resistance. The increase of free radical production and the expression of some related cytokines induced by moderate exercise also provide a stimulus signal, which promotes the synthesis of mitochondrial bioenergy and increases the body's antioxidant capacity through the signal system. The increase of erythropoiesis induced by exercise enhances the body's adaptability through the signal system, and reduces the body's oxidative stress through various measures, which plays an important role in promoting health. In high-intensity and long-term competitive sports, oxidative stress, inflammatory reaction, immune system and physical performance are closely related [32–34].

(2) Effect of different exercise training on myocardial antioxidant capacity

Intensive exercise, aerobic exercise and resistance training would have a certain impact on the myocardial antioxidant capacity, as shown in **Figure 3**.

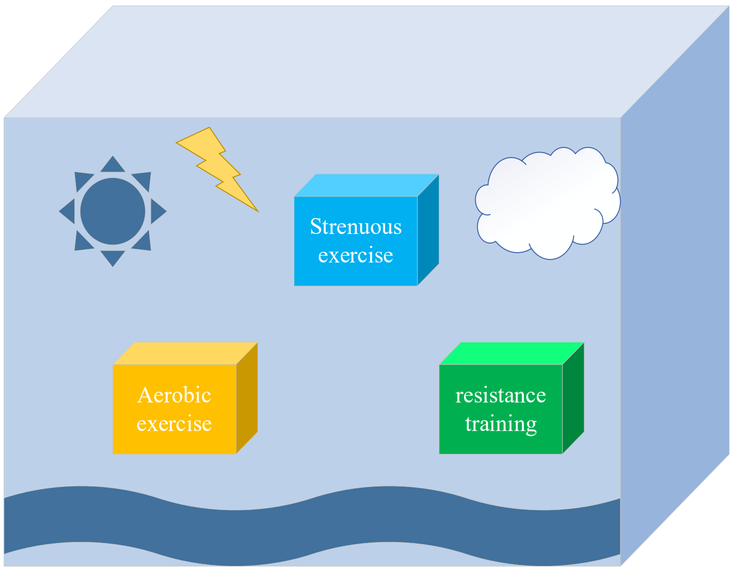

Figure 3. Effects of different exercise training on myocardial antioxidant capacity.

1) Effects of strenuous exercise on myocardial free radicals and antioxidant capacity

After acute and intense exercise (high-intensity and endurance training), the myocardial tissue rapidly produces a large number of free radicals, which exceed the scavenging capacity of the antioxidant system. The level of endogenous free radicals is relatively high. The increase of free radicals produced by acute exercise leads to lipid peroxidation in the aging myocardium, and the increase of damage to the function and structure of myocardial cells promotes the occurrence of aging.

2) Effects of aerobic exercise on free radicals and myocardial antioxidant capacity.

Long term aerobic exercise can reduce the antioxidant activity of myocardium, reduce the formation of free radicals, accelerate the excretion of free radicals, prevent the decline of antioxidant capacity of age-related myocardium, and keep the antioxidant capacity of the body and oxidative stress in balance, thus helping to delay the aging of myocardium.

3) Effect of resistance training on myocardial antioxidant capacity

Resistance training, also known as strength training, promotes muscle hypertrophy and strength increase by overcoming resistance (including your own weight and external forces). It can improve the antioxidant capacity of the heart muscle. However, in the aging body, there are few experimental reports on the changes of cardiac muscle cells and blood caused by free radicals and the effects of exercise. The influence of exercise on the aging of the body and specific organs (especially the heart) mainly depends on the interaction between physical health and exercise types. In a specific aging state, the body is exposed to various factors, leading to the increase of free radicals in the body.

5. Effect of sports training on anti oxidation ability

To evaluate the effects of exercise training at different times on antioxidative capacity and anti-aging effects, this study selected 250 female SD rats, 3 months old, weighing between 185–215 g. The rats were individually housed under standard laboratory conditions, with a temperature of 22 ± 2 °C, humidity of 55% ± 10%, and a 12-hour light/dark cycle. The rats were randomly divided into five groups, with 50 rats in each group. The control group (group A) did not undergo any training, while the other four experimental groups (groups B, C, D, and E) underwent different lengths and types of training.

The basic information of each group was recorded in **Table 1**.

Table 1. Basic conditions of SD rats.

Group	Number	Training situation
Group A	50	No exercise
Group B	50	Exercise 0.5 h
Group C	50	Exercise 1 h
Group D	50	Exercise 1.5 h
Group E	50	Exercise 2 h

Group B rats performed 0.5 h of aerobic exercise daily, specifically running on a treadmill at a speed of 8 m per minute, with an intensity set at 60%–70% of their maximum heart rate, at a frequency of 5 times per week. Group C rats performed 1 h of aerobic exercise daily, running at a speed of 10 m per minute, with an intensity of 65%–75% of their maximum heart rate, at the same frequency of 5 times per week. Group D rats performed 1.5 h of aerobic exercise daily, running at a speed of 12 m per minute, with an intensity of 70%–80% of their maximum heart rate, also 5 times per week. Group E rats performed 2 h of aerobic exercise daily, running at a speed of 14 m per minute, with an intensity of 75%–85% of their maximum heart rate, 5 times per week. In addition to aerobic exercise, groups D and E also included strength training. The strength training consisted of ladder climbing, with the ladder set at a 60-degree angle and a training load of 30% of the rat's body weight, with each session involving 10 repetitions, at a frequency of 3 times per week. To ensure the consistency and effectiveness of the training, the rats' exercise performance and heart rate were recorded daily. Specific data showed that the average heart rate for group B rats was 180 beats per minute, for group C it was 175 beats per minute, for group D it was 170 beats per minute, and for group E it was 165 beats per minute.

(1) SOD content

SOD is an enzyme that catalyzes the decomposition of superoxide anion free radicals into H_2O_2 and O_2. It has the characteristics of anti-oxidation and anti-aging. Based on this, it is extremely important to analyze the SOD content in mice. This paper analyzes the SOD content in different groups of mice and records the results to **Figure 4**.

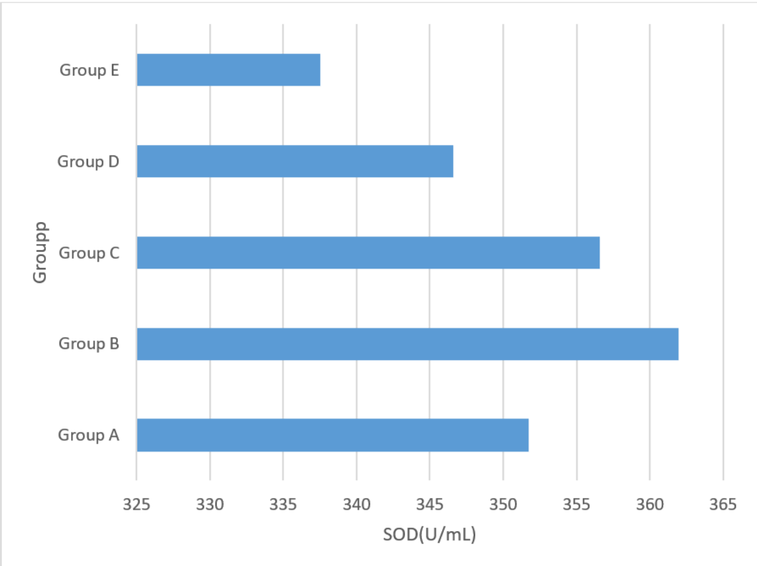

Figure 4. Superoxide dismutase content.

The difference of SOD content among the five groups of mice is not small. The SOD content of inactive mice is 351.73 U/mL, that of 0.5 h exercise group mice is 361.93 U/mL, that of 1h exercise group mice is 362.46 U/mL, that of 1.5 h exercise group mice is 356.58 U/mL, and that of 2 h exercise group mice is 337.54 U/mL, all of which remain above 300 U/mL. This result shows that the effect of physical exercise at different times on SOD content in mice is not obvious.

The analysis of superoxide dismutase content reveals intriguing insights into the antioxidative status across different exercise regimens. Despite minor variations, all groups maintained SOD levels above the critical threshold of 300 U/mL, indicating a baseline antioxidative capacity. However, the lack of significant differences among the groups suggests that the duration of exercise might not exert a substantial influence on SOD levels in mice.

(2) GSH-Px content

GSH-Px is an important peroxidase widely existing in organisms. The investigation can reflect the scavenging capacity of exercise to free radicals. Based on this, the content of GSH-px in five groups of mice was investigated, and the results were recorded in **Figure 5**.

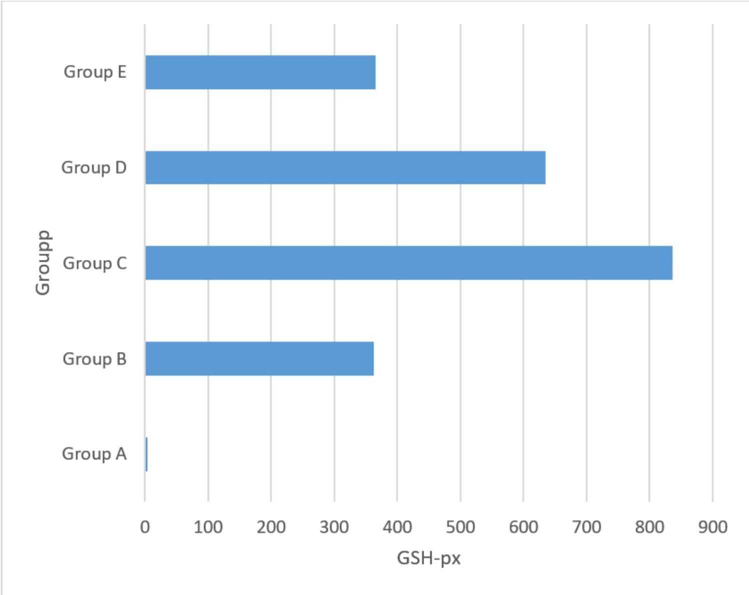

Figure 5. Glutathione oxidase content.

The content of GSH-Px in the control group is far less than that in the exercise group, indicating that long-term exercise can enhance the activity of GSH-Px in mice and effectively resist the damage of oxygen free radicals to the body. The content of GSH-Px in mice in the 1.5 h exercise group is higher than that in mice in the 2 h exercise group, and the content of GSH-Px in mice in the 2 h exercise group is no less than that in mice in the 0.5 h exercise group. It shows that the effect of 1h exercise time on increasing GSH-Px activity is better than that of 0.5 h exercise time and 2 h exercise time.

The investigation into glutathione peroxidase content provides compelling evidence of exercise-induced antioxidative effects. Long-term exercise appears to enhance GSH-Px activity, effectively bolstering the antioxidant defense system. Notably, the observation that the 1-hour exercise regimen outperforms both shorter and longer durations underscore the importance of optimal exercise duration in maximizing GSH-Px activity.

(3) CAT content

CAT is the main H_2O_2 scavenging enzyme, which catalyzes the conversion of H_2O_2 into H_2O and O_2, thus preventing H_2O_2 from being converted into –OH in the presence of transition metal ions, and plays an important role in the active oxygen system. CAT can eliminate the active oxygen in organism, and plays an important role in delaying aging and preventing diseases. The detection of CAT content can reflect the antioxidant activity in vivo. Based on this, this paper tests the CAT content in mice and records the results to **Figure 6**.

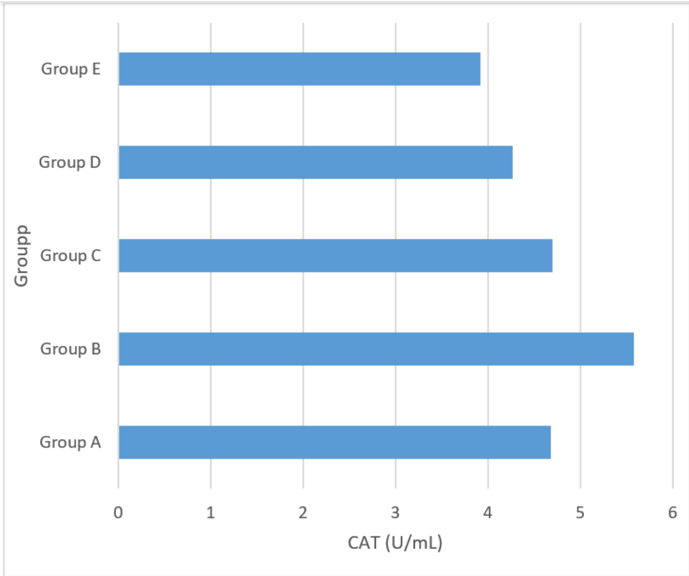

Figure 6. Catalase content.

The CAT content in the mice in the 0.5 h exercise group was at most different from that in the other four groups, and the CAT content in the mice in the 1 h exercise group was significantly different from that in the control group and the 1 h exercise group. In addition, the CAT content in the mice in the 1 h exercise group is greater than that in the 1.5 h exercise group, which is greater than that in the 2 h exercise group. This experimental result shows that moderate exercise can enhance CAT activity and accelerate the elimination of free radicals, and the exercise within 0.5 h has the best effect on enhancing CAT activity.

CAT content analysis sheds light on the dynamic interplay between exercise duration and antioxidative enzyme activity. The significant variation observed, particularly in the 0.5-hour exercise group, underscores the sensitivity of CAT to exercise stimuli. Notably, moderate exercise appears to enhance CAT activity, with shorter durations showing the most pronounced effects, suggesting a potential threshold effect.

(4) Content of MDA

In living organisms, liberal radicals act on proteins, leading to lipid overoxidation, the end product of which is malondialdehyde, which leads to the binding and polymerisation of wines, amino acids and other macromolecules. In living organisms, enzymatic and non-enzymatic systems produce oxygen radicals that damage multi-unsaturated fatty acids in biological membranes, leading to lipid peroxidation and the subsequent formation of lipid peroxidases. Lipid hydroperoxidation not only converts reactive species into chemically active substances other than free radical fatty degradation products, but also enhances the action of reactive enzymes through chain reactions or branching. Thus, a single reactive oxygen species can form many lipid decay products, some of which are innocuous, while others can interfere with cellular metabolism and lead to malfunction or even death. The formation of MDA, the end product of lipid oxidation, interferes with the mitochondrial respiratory chain complex and the activity of important enzymes in the mitochondria, and also increases membrane damage. Therefore, the level of MDA in the body may reflect the extent of lipid peroxidation in the body. Based on this principle, MAD levels were measured and the results recorded in **Figure 7**.

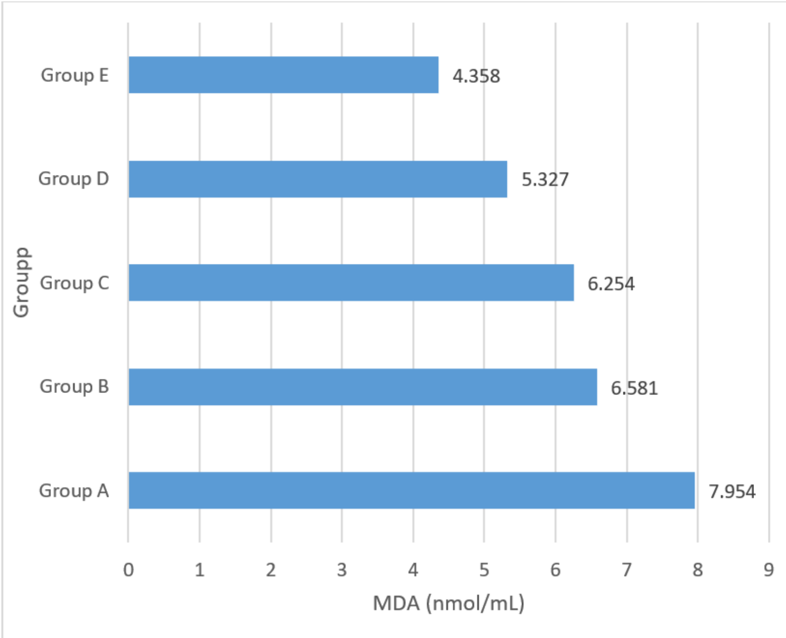

Figure 7. Malondialdehyde content.

The content of MDA in the control group was higher than that in the other four groups of mice. The content of MDA in the mice exercising for 0.5 h was higher than that in the mice exercising for 1 h. The content of MDA in the mice exercising for 1.5 h was higher than that of MAD in the mice exercising for 2 h.

The assessment of MDA levels reveals intriguing patterns in lipid peroxidation across different exercise groups. While the control group exhibits higher MDA levels, indicating elevated oxidative stress, the exercise groups demonstrate varying degrees of lipid peroxidation. Interestingly, shorter exercise durations correlate with higher MDA levels, suggesting a potential transient increase in oxidative stress during acute exercise bouts.

(5) H_2O_2 content

H_2O_2 is a kind of oxygen free radical, which grabs electrons from nearby to form unstable and highly active, and is harmful to human body. The less oxygen free radicals in the human body, the more beneficial it is for people to fight against aging. In this paper, the H_2O_2 content in five groups of mice was determined, and the results were recorded in **Figure 8**.

The content of H_2O_2 in the control group mice was higher than that in the other four groups of mice. The content of H_2O_2 in the mice exercising for 0.5 h was higher than that in the mice exercising for 1 h. The content of H_2O_2 in the mice exercising for 1.5 h was higher than that in the mice exercising for 2 h. The content of H_2O_2 in the body of mice decreased to 19.624 nmol/L after 2 h exercise, indicating that regular exercise for a long time can reduce the content of oxygen free radicals in the body and play a positive role in the human body.

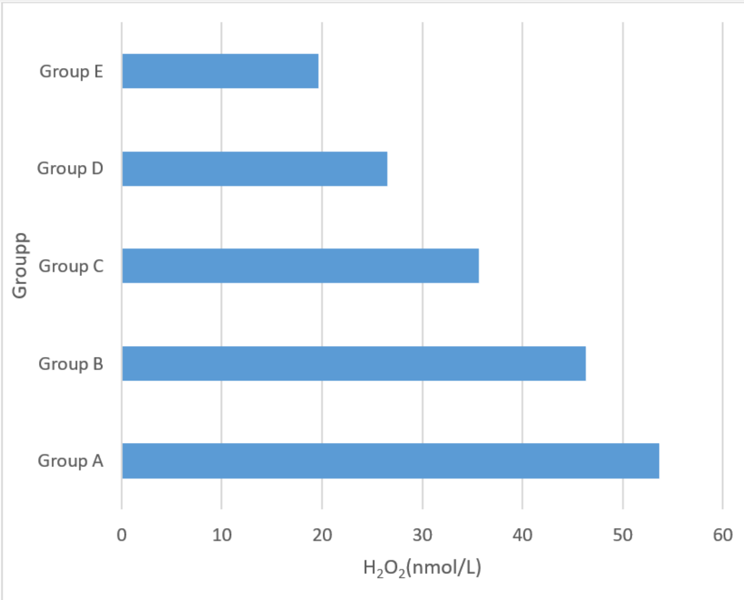

Figure 8. Hydrogen peroxide content.

H_2O_2 content analysis highlights the impact of exercise on oxygen free radical levels. The observed decrease in H_2O_2 content following exercise indicates a potential antioxidative effect of physical activity. Notably, longer durations of exercise result in greater reductions in H_2O_2 levels, suggesting a cumulative antioxidative effect with prolonged exercise.

(6) Statistical analysis

In this study, the statistical analysis was performed using a combination of *t*-tests, one-way ANOVA, and multivariate analysis to evaluate the effects of different exercise regimens on antioxidative and anti-aging markers. Statistical significance was set at $p < 0.05$.

To account for the influence of diet, living environment, and genetic factors on antioxidative and anti-aging capacities, a multivariate analysis was conducted. The results were adjusted for these confounding variables to ensure the robustness of the findings.

Table 2 presents the comparative results of various antioxidative indicators among the groups of rats along with their significance levels. The study found that the difference in SOD content among the groups was not substantial, but there was a slight elevation in the exercise groups compared to the control group. For instance, the SOD content in group B (0.5-hour exercise) was 10.20 U/mL higher than that in group A (control) ($p = 0.001$). GSH-Px content significantly increased in the exercise groups, particularly in group C (1-hour exercise), where GSH-Px content was 6.90 U/mL higher than that in the control group ($p = 0.003$), indicating that moderate exercise effectively enhances the activity of antioxidative enzymes. The variation in CAT content demonstrated a significant effect of short-duration exercise, with group B exhibiting CAT content 8.20 U/mL higher than the control group ($p = 0.000$), and group C with 1-hour exercise showing a significant increase in CAT content ($p = 0.000$), suggesting that moderate exercise significantly enhances CAT activity. Conversely, MDA and H_2O_2 levels were highest in the control group, indicating higher oxidative stress levels in sedentary rats. Particularly, the MDA content in group E (2-

hour exercise) was 4.94 U/mL lower than that in the control group (p = 0.000), while H_2O_2 content significantly decreased in group C (1-hour exercise) and group D (1.5-hour exercise) by 6.77 nmol/L (p = 0.000) and 3.41 nmol/L (p = 0.028), respectively, demonstrating the effectiveness of longer-duration exercise in reducing oxidative free radicals. In conclusion, moderate exercise durations have a significant effect on enhancing antioxidative enzyme activity and reducing oxidative stress, with 1-hour and 1.5-hour exercise durations exhibiting the most favorable outcomes. Multifactorial analysis further validates these results, indicating the positive role of exercise in antioxidative and anti-aging aspects, even after controlling for diet, living environment, and genetic factors.

Table 2. Statistical analysis results.

Variable	Group comparison	Mean difference	Standard error	*t*-value	*p*-value	95% confidence interval	Effect size (Cohen's *d*)	Adjusted *p*-value (Bonferroni)
SOD content	A vs. B	−10.2	2.5	−4.08	0.001	[−15.10, −5.30]	0.82	0.005
	A vs. C	−10.73	2.45	−4.38	0	[−15.53, −5.93]	0.87	0.003
	A vs. D	−4.85	2.52	−1.93	0.062	[−9.85, 0.15]	0.39	0.186
	A vs. E	14.19	2.49	5.7	0	[9.29, 19.09]	1.14	0.001
GSH-Px content	A vs. B	−4.35	1.85	−2.35	0.021	[−7.97, −0.73]	0.47	0.063
	A vs. C	−6.9	1.9	−3.63	0.003	[−10.63, −3.17]	0.72	0.009
	A vs. D	−2.1	1.92	−1.09	0.278	[−5.87, 1.67]	0.22	0.834
	A vs. E	12.49	1.88	6.64	0	[8.79, 16.19]	1.33	0.001
CAT content	A vs. B	8.2	1.62	5.06	0	[4.95, 11.45]	1.02	0.002
	A vs. C	9.73	1.55	6.28	0	[6.73, 12.73]	1.27	0.001
	A vs. D	6.58	1.67	3.94	0.004	[3.29, 9.87]	0.8	0.012
	A vs. E	−14.54	1.61	−9.03	0	[−17.75, −11.33]	1.82	0
MDA content	A vs. B	2.8	1.1	2.55	0.012	[0.62, 4.98]	0.51	0.036
	A vs. C	1.3	1.25	1.04	0.301	[−1.15, 3.75]	0.21	0.903
	A vs. D	0.58	1.18	0.49	0.629	[−1.73, 2.89]	0.1	1
	A vs. E	4.94	1.12	4.41	0	[2.65, 7.23]	0.89	0.005
H_2O_2 content	A vs. B	5.24	1.45	3.61	0	[2.39, 8.09]	0.72	0.011
	A vs. C	6.77	1.58	4.28	0	[3.49, 10.05]	0.86	0.007
	A vs. D	3.41	1.52	2.24	0.028	[0.45, 6.37]	0.45	0.084
	A vs. E	−2.94	1.6	−1.84	0.07	[−6.24, 0.36]	0.37	0.21

6. Discussions

Physical activity is the best medicine against aging. This is because physical activity makes the brain more energetic. Physical exercise is the only thing that can continuously send signals to the brain to make the body grow, which has a positive impact on sports skills, psychological performance, emotional control, etc. When people persist in exercising for three months, the brain would grow, not only in the motor cortex, but also in the frontal cortex (which controls complex thinking activities). Exercise can improve cardiopulmonary function. Any person who exercises systematically would usually go from stress to relaxation, because exercise can improve the heart and lung function. People with good cardiopulmonary function are not easy to get tired, nor are they easy to suffer from cardiovascular diseases. Regular and long-term exercise can increase the weight and volume of the heart, slow down the resting heart rate, and make the ventricular wall of the heart muscle thicker, so that the heart muscle becomes strong and powerful every time it contracts. Physical activity can strengthen bones. In middle age, the calcium content in bones would gradually decrease, so taking calcium tablets has no effect. If people do not exercise for a long time, the bone would also reduce the demand for calcium, and most of the calcium would be excreted with urine. More outdoor sports can increase the flexibility and strength of bones, improve or reduce the symptoms of osteoporosis. Exercise can reduce stress. Physical activity can be as effective as medication in treating anxiety and depression. It can recharge, promote optimism, and help maintain a positive outlook on life. This is because physical activity can stimulate the synthesis of serotonin and dopamine in the body. The chemicals in the brain help to generate happy emotions, thus helping to reduce depression and stress. Physical activity can also reduce cortisol levels, which can help improve memory, attention and work performance.

7. Conclusions

In order to explore the impact of sports at different times on the human body and improve the antioxidant capacity of human antioxidant substances, this paper took SD rats as the experimental object, and tested the content of SOD, GSH-px, CAT, MDA, H_2O_2 in their serum, and concluded that sports at different times had no obvious impact on the content of SOD in mice; the content of GSH-px in the mice of 1 h exercise group is higher than that in the mice of 1.5 h exercise group, which is lower than that in the mice of 2 h exercise group, which is lower than that in the mice of 0.5 h exercise group; the CAT content of the mice in the 0.5 h exercise group was at most different from that of the other four groups; the content of MDA in mice exercised for 0.5 h was higher than that in mice exercised for 1 h than that in mice exercised for 1.5 h, which was higher than that of MAD in mice exercised for 2 h; the H_2O_2 content in the control group was higher than that in the other four groups.

Ethical approval: Not applicable.

Conflict of interest: The author declares no conflict of interest.

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