

Influence of Tobacco on Physical Fitness Recovery of College Students After Sports

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Objectives: In this paper, the effects of tobacco on aerobic exercise ability and physical fitness recovery of college students were studied. **Methods:** University group sports intervention form: traditional characteristic project (basketball) + Taiji soft ball (R&D intervention project). **Exercise time:** 3 times/week; **Activity duration:** 30min; **Activity intensity:** the heart rate is controlled at 120-140 beats/min. All the college students in the experimental group are students who have never smoked, and the college students in the control group are students who have smoked for more than two years. The other conditions are the same. **Results:** The exercise time and endurance of experimental groups I and II were significantly lower than those of the control group, and the cardiopulmonary function was significantly lower than that of the control group. The indexes of experimental group II changed significantly compared with experimental group I, and the difference was statistically significant. **Conclusion:** Cigarette smoke can significantly reduce the aerobic exercise ability and anti fatigue ability. The longer the smoking time, the more serious the adverse effects. Therefore, tobacco smoke and nicotine will damage college students' aerobic exercise ability and have a negative impact on the recovery of physical fitness after exercise.

Key words: tobacco, nicotine, sports, physical fitness, physical recovery

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The World Health Organization global tobacco epidemic report points out that tobacco is six of the eight leading causes of death in the world (one of the important risk factors for lung cancer, ischemic heart disease, cerebrovascular disease, chronic obstructive pulmonary disease, lower respiratory tract infection and tuberculosis. Tobacco can release more than 4000 kinds of chemicals during combustion, including nicotine, tar, carbon monoxide, benzopyrene, vinyl chloride, methylene amine, and a large number of toxic and harmful chemicals such as cadmium, arsenic and mercury. Cancer and radioac

tive substances¹. Nicotine has strong central neurotoxicity, which makes smokers dependent on tobacco, makes smoking a chronic addictive disease, and chronic nicotine poisoning is caused by long-term inhalation.

The US health director report summarizes the results of smoking and chronic obstructive pulmonary disease research from 1966 to 2001. The conclusion is that smoking has a greater impact on the incidence rate and mortality of chronic obstructive pulmonary disease than other factors, and is the main cause of chronic obstructive pulmonary disease. In addition, smoking has an impact on reproductive function, pregnancy outcome, fetal and child development,

resulting in the decline of male sperm and semen quality. Severe can lead to erectile dysfunction. Smoking in pregnant women can lead to ectopic pregnancy, fetal growth restriction and low birth weight of newborns. In severe cases, it can cause abortion and sudden infant death. Research data show that the average life expectancy of people who smoke 10 ~ 19 cigarettes a day is 5.5 years shorter than that of non-smokers²⁻³.

Smokers are not the only victims of tobacco use, and second-hand smoke also has serious harm. Inhalation of second-hand smoke, also known as passive smoking, means that non-smokers inhale tobacco smoke for more than 15 minutes at least one day a week, and there is no safe exposure level of second-hand smoke, that is, short-term exposure will be harmful to human body. Tobacco smoke in the environment actually consists of two kinds of smoke: mainstream smoke and tributary smoke. Mainstream smoke mainly refers to the smoke in smokers' inhalation; Tributary smoke is the smoke emitted to the external environment during tobacco combustion, that is, the smoke inhaled by passive smokers.

Due to the incomplete combustion of tributary smoke, the content of some harmful chemical components is much higher than that of mainstream smoke. Inhalation of second-hand smoke can not only cause a variety of diseases, including a variety of cancers (lung cancer, esophageal cancer, etc.), respiratory diseases (asthma, respiratory infection, etc.), cardiovascular and cerebrovascular systemic diseases (coronary heart disease, stroke), etc., but also cause serious harm to the health of women and children. Second hand smoke can cause female endocrine disorder and reduce pregnancy rate. There is sufficient evidence that exposure of pregnant women to second-hand smoke can cause neonatal neural tube malformation, cleft lip and palate, and more serious can cause low birth weight⁴.

METHODS

Materials

University group sports intervention form: traditional characteristic project (basketball) + Taiji soft ball (R&D intervention project).

Exercise time: 3 times/week; Activity duration: 30min; Activity intensity: the heart rate is controlled at 120-140 beats/min. All the college students in the experimental group are students who have never smoked, and the college students in the control group are students who have smoked for more than two years. The other conditions are the same.

Method

(1) Grouping

Thirty male and female college students were randomly divided into experimental group, i.e. passive smoking group I, passive smoking group II and control group (non-smoking), half male and half female.

(2) Environment Method

Passive smoking group I smoked twice a day, starting at 8 a.m. and 4 p.m. for 14 consecutive days, passive smoking for 1H each time, a total of 6 cigarettes. The number of times, starting time and duration of smoking in passive smoking group II were the same as those in passive smoking group I, but each smoking time was prolonged for 2h and the amount of smoking was doubled. The other conditions were the same.

(3) Exposure time and smoke control

The growth environment will also have an impact on the diet and constitution, so comprehensive consideration should be given to the design of experimental exposure time. In order to eliminate the adverse effects of long-term smoking environment on tester's diet and other physique, a 2-week smoking cycle is specially designed to avoid the effects caused by too short experimental cycle time, inconspicuous experimental effect, too long cycle time and too many other interference factors. At the same time, in order to distinguish the influence of smoking volume or long time, the number of cigarettes and smoking time in experimental group II were doubled compared with experimental group I, so as to distinguish the influence of smoking volume. In the process of exposure, 90% and 10% of the main side stream smoke were controlled, the concentration of total suspended particulates (TSP) was controlled to 120 mg.m⁻³, and the contents of CO, CO₂ and O₂ were monitored. The contents of

TSP and CO were used as smoking exposure indicators.

(4) Pulmonary function measurement

Under the condition that the living environment is basically similar, 46 people in the exercise group and less exercise group are selected, including 36 people aged 18-22 and 10 people aged 23-25, half of men and half of women. The exercise group insisted on exercise for more than 2 years, no less than 4 times a week, no less than 30 minutes each time. Sports include morning running, jogging, brisk walking, swimming, ball games, single and parallel bars, etc. The less exercise group chose those who did not exercise consciously. Smoking group and non-smoking group, the former chooses those who smoke more than 400 cigarettes a year, and the latter chooses those

who smoke less than 20 cigarettes a year. The two groups had 20 people aged 18-22 and 20 people aged 23-25, half of men and half of women, and both had less exercise. The lung function was measured by Nissan automatic lung function instrument. The counter is used to count the number of breaths in one minute under room temperature 20 °C and measurement condition 37 °C.

Data processing

The data obtained in this study are expressed in ($\bar{x} \pm s$) and processed by SPSS 13.0. The measurement data are compared by t-test, $P < 0.05$ is statistically significant.

RESULTS

The changes of swimming time after the experiment are shown in Table 1.

Table 1
The Experimental Group and the Control Group Swimming Time After Smoking Experiment
Index Comparison (n = 10, $\bar{x} \pm s$)

Group	Number of cases (PCs.)	Average time of exhaustive swimming after experiment (min)
Control group	10	276.57±45.97
Experimental group I	10	215.57±29.49
Experimental group II	10	176.54±21.79

It can be seen from table 1 that after the smoking experiment, the swimming time and endurance of the experimental group are lower than those of the control group. The difference was statistically significant ($P < 0.05$). There were significant changes in the indexes of the two groups compared with the first group. The results showed that passive smoking had adverse effects on aerobic exercise ability and antioxidant ability. The longer smoking time, the more serious side effects.

Results of exercise intervention experiment in University Group

University stage is an important stage of growth and development in one's life. During this period, human metabolism is relatively vigorous,

assimilation is dominant, and various tissues and organs of the body continue to grow and develop. Skeletal muscle develops rapidly, and the cardiovascular system and nervous system have developed greatly. Neural excitation process is dominant, fast response and easy to be excited. However, the development of the heart lags behind the development of the motor system and nervous system, with poor motor sustainability and easy fatigue. These physiological mutations have caused corresponding changes in psychology and behavior: first, because the body has a vigorous metabolism, energy, vitality, lively and active, and likes sports and competitions to express itself. Second, due to the unbalanced physical development and the poor regulation ability of the

central nervous system, the movement is clumsy, awkward, inflexible, and prone to dizziness and fatigue. Third, the sense of adulthood comes into being and gradually becomes aware of the body

shape, and begins to evaluate others and self-evaluation. The comparison before and after exercise intervention is shown in Table 2.

Table 2
The comparison before and after exercise intervention

Index	Project	Before exercise intervention	After exercise intervention	T
		$\bar{x} \pm s$	$\bar{x} \pm s$	
Morphological index	Height	171.4±0.57	171.84±0.56	-0.846
	Weight	63.3±1.10	60.9±1.09	-3.265***
	Upper arm sebum thickness	14.1±0.82	11.2±0.50	6.785***
	Scapular sebum thickness	16.9±1.02	16.7±0.75	0.317
	Abdominal sebum thickness	18.5±0.95	16.1±0.78	2.569**
Functional index	Vital capacity	4208.4±81.35	4598.5±71.33	6.871***
	Step test	56.5 ± 1.68	58.70±1.12	2.52**
	Grip	39.4±0.61	40.8±0.66	2.240**
	Pull up	4.3±0.34	4.6 ± 0.28	-1.128
physical quality	Standing long jump	2.10±0.27	2.37±0.22	4.71***
	Reaction time (1)	0.16±0.01	0.14±0.01	1.987*
	Reaction time (2)	0.36±0.01	0.35±0.05	1.211
	Stand on one foot with eyes closed	30.2±2.52	43.6±2.50	-5.746***

Notes: *: P<0.05 **: P<0.01 ***:P<0.001

For college students without smoking experience, the t-test results show that there is a highly significant difference between the two test items of pull-up and standing long jump. In the two test items of functional indexes, the results of vital capacity test showed significant difference, while there was no difference in the five test items of morphological indexes. Before and after exercise intervention, there were highly significant differences in several key test items (weight, upper arm sebum thickness, abdominal sebum thickness, grip strength, sit ups and standing long jump) from the change range of T value. Although other indicators did not show the opposite sex, it can be seen from the average value before and after exercise intervention that through the implementation of exercise intervention, It also has a positive impact on the development of the body. For college students with smoking experience, the results

of t-test show that there are highly significant differences in vital capacity, sit ups and standing long jump between function and physical quality. There was no difference in the 11 test items of other indicators. Smoking can harm your ability to exercise. One reason is that smokers are more likely to feel tired than non-smokers. During exercise, muscles need more oxygen than at rest. Smoking constricts and blocks blood vessels, resulting in insufficient oxygen from the blood to the muscles. Moreover, carbon monoxide in cigarette smoke consumes oxygen in the blood.

Therefore, there are highly significant differences in body weight, upper arm, shoulder blade and abdominal sebum thickness in the experimental group, which proves that the implementation of exercise intervention has an obvious effect on improving the body shape of non-smoking college students and controlling the occurrence of obesity. There are obvious differences in vital capacity and step test index of non-smoking college students,

which proves that the implementation of exercise intervention plays a positive role in enhancing the cardiopulmonary function of non-smoking college students. For college students who smoke, sports intervention has no obvious effect on them.

DISCUSS

Aerobic exercise ability refers to the body's ability to exercise for a long time based on aerobic metabolism. The factors that determine and affect aerobic exercise ability include cardiopulmonary function, muscle oxygen utilization ability, gender and age. Low load or no load exhaustive exercise time is the main method to judge the aerobic exercise ability⁵⁻⁶. Studies have proved that tar and other harmful substances in smoke can adhere to the surface of trachea, bronchus and alveoli of passive smokers and inhibit ciliary movement⁷⁻¹⁰. And increase the oxygen free radicals released by alveolar macrophages and blood neutrophils, and then increase the adhesion between leukocytes and endothelial cells, form inflammatory reaction, and finally lead to the destruction and dysfunction of lung tissue. Nicotine can cause the increase of blood pressure, the acceleration of heartbeat, the decline of cardiac pumping function, the increase of oxygen consumption, and the decline of aerobic exercise ability. The results of this study are consistent with it. First of all, we all know that smoking will affect lung function. In normal people, 70% of the lungs are in a standby state in a calm state. This part of the lungs will work only when we exercise. Therefore, there may be no discomfort in the early stage of smoking in a calm state. But when you want to exercise like HIIT and challenge 80% or higher of your maximum heart rate, you will obviously feel limited lung function. Almost all people who have smoked for more than 20 years will suffer from chronic bronchitis, emphysema and chronic obstructive pulmonary disease, which may lead to dyspnea at rest.

Secondly, nicotine and other components in cigarettes will cause damage to the endothelium of blood vessels. At the same time, it also affects the normal diastolic and systolic function

of blood vessels. This is also the basis for smoking to increase the incidence rate of hypertension and atherosclerosis. During exercise, the body will expand the blood vessels of the muscles involved in exercise as much as possible to ensure that the muscles absorb enough oxygen and energy. When the vascular function is impaired, it will lead to the impairment of muscle endurance. At the same time, because the function of small blood vessels is affected, it will also lead to slower recovery of muscles after exercise. Strength training without full recovery can cause great damage to muscles.

Finally, smoking increases the excitability and metabolic rate of the central nervous system. This is also why many people who smoke heavily are thinner and tend to get fat after quitting smoking. These two points sound to have no negative impact on sports, and may even have a positive effect, but this is not the case. Sports improve the metabolic rate by increasing the content of body muscles. Muscle itself belongs to tissue with high metabolism and high water content. If it is through the intake of exogenous substances to improve metabolism, it will affect the heart function. Some weight-loss drugs also claim to improve the metabolic rate to lose weight. Such substances may cause tachycardia, palpitation and other symptoms, similar to mild "hyperthyroidism". This state must be unhealthy. In the long run, it will only cause damage to heart function.

The results show that exercise can increase vital capacity, reduce functional residual capacity and residual capacity, reduce the ratio of residual capacity to total lung capacity, increase the maximum ventilation, and improve the lung function and body tolerance. Smoking has great damage to lung function. In the smoking group, the vital capacity decreased, the functional residual capacity and residual capacity increased, the ratio of residual capacity to total lung capacity increased, and the maximum ventilation decreased, indicating that the health status decreased¹².

When people exercise, they always consume energy. The ultimate source of energy is the oxidative decomposition of energy substances (sugar, fat, protein, etc.). Their catabolism requires the supply of oxygen. In order to meet the needs of oxygen during exercise, the amount of oxygen

should be increased accordingly. The amount of oxygen absorbed is closely related to the function of oxygen transport system. The impact of smoking on oxygen transport system has been mentioned above. Obviously, smoking also has an impact on indispensable oxygen sports, especially on endurance sports with large oxygen demand.

As mentioned earlier, smoking will increase airway resistance and affect pulmonary ventilation function. However, it should be known that the small particles in the flue gas stimulate bronchoconstriction, resulting in increased airway resistance, which may not be easy to detect at rest, but it will be obvious that the lung ventilation is extremely laborious during exercise, because the requirements for lung ventilation increase at this time, and this effect will be shown negatively. Because of this, forced expiratory volume and random maximum ventilation may decrease. When exercising violently, the airway resistance of regular smokers is twice that of non-smokers. It should be noted that the airway resistance of subjects with smoking habits who had not smoked within 24 hours before exercise was still significantly higher than that of non-smokers. In view of this situation, frequent smoking will increase the resistance of lung ventilation and significantly reduce the available oxygen of working muscles.

In this way, endurance exercise performance, lung ventilation and maximum oxygen intake will be significantly reduced. However, it has been suggested that smoking a few cigarettes before exercise can boost people's spirits and improve their exercise ability. Is that true? It's not. After smoking, under the stimulation of smoke components, although it makes brain cells slightly excited, it has little effect on the mobilization and play of motor and plant functions. On the contrary, the adverse effect of flue gas on oxygen transport system is quite obvious. It has been reported that after smoking a cigarette, the tracheal resistance can be doubled within a few seconds. It can also be reported that during vigorous exercise, the ventilatory oxygen value of long-term smokers is about twice that of non-smokers. Even if you

only smoke a little within an hour before exercise, the result is the same. If smokers quit smoking for 24 hours before exercise, the ventilatory oxygen value can be reduced by 25%, but it is still about 50% higher than that of non-smokers.

In addition, when smoking before exercise, Hb is more inclined to carry CO rather than O₂ in the smoke, so the oxygen carrying capacity of Hb is bound to be reduced. Therefore, it is unfavorable to the exertion of sports ability and the improvement of sports competitive level. Especially for long-lasting sports, such as running for 5 minutes or more, or discontinuous scattered but long-term sports at a given speed, such as UFO, football and basketball, smoking has a more adverse impact on the sports function of athletes' endurance. Therefore, there is no reason to say that smoking before exercise can improve exercise ability.

The effect of smoking on exercise ability is also reflected in the regulatory mechanism of the heart during exercise. After a comparative experiment, it is reported that the heart rate of smokers was 10 ~ 20 times / min higher than that of smokers before the experiment¹³. The difference of heart rate between smokers and non-smokers is that the greater the exercise load, the greater the heart rate difference. This is because smoking has an impact on the regulatory mechanism of cardiac work, resulting in a significant increase in heart rate period when exercise load increases. In this way, the energy consumption of myocardium increases and the blood pumping function of the heart is affected.

The influence of smoking on oxygen transport system seriously hinders the exertion of exercise ability. Therefore, we must educate and advise athletes to give up smoking in order to improve their exercise ability. Halley pointed out that it is particularly important to educate young athletes about the harm of smoking and ask them not to smoke¹⁴⁻¹⁵. At the same time, it should also be noted that spectators should be prohibited from smoking during indoor competitions and training. After smoking, airway resistance increased two to three times in a few seconds and maintained for 10 to 30 minutes. If you do not smoke within 24 hours before exercise, the increase of airway resistance can be significantly relieved. After smoking, it takes a day or more for the content of CO in blood to return to

normal level. The results provide a basis for some people who can't quit smoking for at least a short time before exercise. The author believes that if athletes (especially endurance athletes) do not want to give up smoking, they should strive not to smoke within 24 hours before sports, which may be helpful to improve athletes' sports ability and strive for better sports performance. Some people may think that athletes in sprint, shot put and diving do not have significant requirements for aerobic ability and are not affected by smoking, so they do not have to quit smoking. If we look at the development trend of modern sports, even technical athletes have to endure intense or even long-term training, and the requirements for oxygen transport system should be high. Although smoking will not affect their performance during the competition, it is also necessary to quit smoking during their training.

In conclusion, cigarette smoke can reduce the activity of serum SOD and increase the content of MDA which is an important reason to reduce the ability of aerobic exercise and anti fatigue, delay the elimination of fatigue and functional recovery, and the longer the smoking time, the more serious the adverse effects.

Conflicts of Interest Disclosure Statement

The authors declare no conflict of interest in the authorship or publication of this work. The authors declare no sponsored financial sources by any organization related to tobacco production for the undertaken study.

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