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LETTER TO THE EDITOR

Modeling Study on the Effect of Atmospheric Environmental Quality on Cardiopulmonary Function of Rock Climbing Athletes

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To explore the effect of atmospheric environmental quality on the cardiopulmonary function of rock climbers. Method: 20 rock climbers were selected as experimental group (EG), healthy people who did not participate in rock climbing as positive control group (CG1); Healthy people who did not take part in physical exercise were selected as negative control group (CG2) in clean area. Each group selected 15 people. The exercise cardiopulmonary function testing system was used to test the cardiopulmonary function of subjects in different states. The results show that the detection model of atmospheric environmental pollution is established from the perspective of athletes' health, and the corresponding solutions are put forward. Air pollution has adverse effects on cardiopulmonary function and aerobic metabolism. At the same time, the harm of atmospheric environmental quality to the respiratory system of rock climbers is significantly greater than that of the general population.
Environmental quality; Rock climbing; Cardiopulmonary function; Pollution

1 INTRODUCTION

Epidemiological investigation and research have confirmed that if people live and work in air pollution environment for a long time, it will lead to the decline of cardiopulmonary function and increase the morbidity and mortality of cardiopulmonary diseases (Cole-Hunte et al, 2017). Because the mode of breathing during exercise transits from nasopharyngeal breathing to nasopharyngeal and oropharyngeal mixed breathing mode, if a person exercises in an air-polluted environment, it will weaken the filtering function of nasal cavity to air. With the increase of ventilation per minute and the acceleration of breathing frequency during exercise, more harmful substances in polluted air are absorbed into the body and diffused into the blood through the function of lung ventilation. The harmful effects of pollutants on human body are obviously increased (Jang DJ et al, 2017, Zeng et al. 2017; Khelif et al. 2016). The preliminary research results of our laboratory confirm that physical exercise can improve the cardiopulmonary function of human body, save energy utilization and improve work efficiency (Fandiño-Del-Rio et al, 2017). But the human body in the polluted environment movement is more likely to cause the body's inflammatory response, increase the susceptibility to disease (Wang et al, 2018). Accordingly, this study attempts to compare the difference of cardiopulmonary function between the general population and the sports population in the heavily polluted area by static and dynamic cardiopulmonary function tests, and objectively evaluate the effect of air pollution on the cardiopulmonary function of rock climbers (Franchini & Mannucci, 2018).

Aidosov et al. 2019) published an article entitled "Mathematical Modelling of Atmospheric Pollution in an Industrial Region with a View to Design an Information System Software for Ecological Situation" in Ekoloji's

Issue 107. Based on the mathematical model of air pollution, this paper studies the information system for monitoring and evaluating the ecological status of industrial zones. Our model allows the collection of real-time data and the assessment of the possibility of contamination diffusion. The object of study is the change of air composition under natural and artificial factors.The purpose of the study is to design an information system software for monitoring and assessing the ecological conditions of industrial zones.The mathematical model based on hydrothermodynamic equation is used to study the local atmospheric processes in the boundary layer.On the basis of this study, a model of the influence of atmospheric environmental quality on the cardiopulmonary function of rock climbers was established.

2 IDEA DESCRIPTION

2.1 Research object

The subjects were 20 athletes from a rock climbing organization. Training is conducted from 14 to 18 p.m. on Mondays to Saturdays. The average age of athletes is 20 years old, male, non-smoking, good health, no major lung diseases, living in PM2.5 surveillance area for more than 2 years, no upper respiratory tract infections (such as colds and coughs) during the surveillance period.During the study period, the height and weight of athletes were measured according to the standard method, and the basic data of age were also counted.

2.2 Instrument and equipment

Portable Aerosol Monitor (TSI8530, TSI Instrument Company, USA) and CHEST Lung Function Tester (HI-101, Jester Company, Japan).

2.3 Atmospheric Environmental Quality Monitoring

From 0:00 on January 19, 2017 to 0:00 on February 7, and from 0:00 on March 16 to 0:00 on April 25, 2017, portable aerosol monitor (TSI8530, TSI Instrument Company of America) was used to monitor the average PM2.5 mass concentration per hour during the study period, and 61 days'data were collected. During the sampling period, PM2.5 concentration data were collected from the national real-time publishing platform of urban air quality every hour in Taiyuan.

2.4 Measurement of pulmonary function

Specific procedures: Before the measurement of lung function, the data needed for the measurement, including athletes'names, gender, age, height and weight, are correctly input into the instrument display screen.Ethnic selection "Asia". When measuring, athletes take a standing posture, clip nose clips, including a jacket, and make strict determination according to the requirements of each index in the instructions of the pulmonary function instrument. Each index can be measured H times at most, and the best data can be printed at last.Before pulmonary function measurements, the investigators were trained and their operation was strictly checked. The flow rate of the instrument was corrected before and after use to ensure the accuracy of the final measurement results.Lung function is a sensitive index of human body, which is usually used as an important standard to measure human health.In order to avoid the influence of physical factors such as race, sex and weight on the average level of pulmonary function indicators, we selected the percentage of the actual measured values of pulmonary function indicators and the predicted values based on the basic data of age and height as dependent variables under different load and different concentration of PM2.5.

The main indicators included absolute and relative maximum oxygen uptake (VO2max, VO2max/kg), oxygen pulse (O2 P), anaerobic threshold (AT), absolute and relative oxygen uptake (VO2, VO2/kg), oxygen uptake to maximum oxygen uptake ratio (VO2/VO2max), metabolic equivalent (MET s), ventilation per minute (VE), maximum respiratory rate (RFmax), physiological dead space to tidal volume ratio (DV/TV), oxygen

ventilation equivalent (EQO 2). VE/VO2, heart rate (HR), vital capacity (VC), systolic pressure (SP), diastolic pressure (DP), pulse pressure (PP), mean arterial pressure (MAP), exercise load (LOAD) and so on.

2.4.1 Comparison of cardiopulmonary function indexes in quiet state

In quiet state, HR in EG group was significantly lower than that in CG1 group, VC and DP group was significantly higher than that in CG2 group ($P < 0.05$), and SP value had no significant difference compared with the other two groups. Among the three groups, the PP value of EG group was the lowest and the MAP value was the highest, which was significantly different from that of CG2 group ($P < 0.05$).

2.4.2 Comparison of Cardiopulmonary Function Indicators at AT

In AT state, VO2, VO2/kg, O2 P and MET s in CG1 group were significantly lower than those in CG2 group ($P < 0.05$), while HR, VD/VT, EQO 2, VO2/VO2max had no significant difference ($P > 0.05$).

2.4.3 Comparison of Cardiopulmonary Function Indicators in VO2max

In VO2max state, VO2max, VO2max/kg, O2 P and METs in EG group and CG1 group were significantly lower than those in CG2 group ($P < 0.05$, $P < 0.01$). There was no significant difference in the values of H R and VD/VT between the three groups. EQO 2 was the highest in EG group and the lowest in CG2 group. Both EG group and CG1 group were significantly higher than CG2 group ($P < 0.05$). The exercise load of EG group and CG2 group was significantly higher than that of CG1 group ($P < 0.05$). There was no significant difference between VEmax and RFmax groups ($P > 0.05$).

2.4.4 Comparison of other indicators

The duration time of exercise (DT) in EG group was significantly longer than that in CG1 group ($P < 0.05$). There was no significant difference in HR between groups one minute after the end of exercise load test ($P > 0.05$). In order to avoid the deviation caused by different baseline heart rates, the heart rate recovery value A = maximum heart rate at exercise - heart rate at 1 minute after exercise) / (maximum heart rate at exercise - quiet heart rate) was used to compare. The results showed that the recovery of heart rate in EG group was the slowest after exercise, and there was a significant difference between EG group and CG2 group ($P < 0.05$).

3 DETECTION MODEL OF ATMOSPHERIC ENVIRONMENTAL POLLUTION

Air pollutants entering the heart and lungs of rock climbers through breathing will cause damage to the athletes'heart and lung system, and then cause diseases, lead to heart and lung organ pathological changes, resulting in changes in health.Through the test results, the detection model of atmospheric environmental pollution was established from the perspective of athletes'health.

Hypothesis, S as a health impact factor，i as the incidence of disease，λas the incidence of health terminal events。To extract the health information of climbers, the expression is as follows:

$$y=\frac{s+i}{\lambda} \tag{1}$$

The health information of rock climbers is combined with air microorganisms. a is the a line of athletes'health information.，α is the pollutant index. β is the concentration of pollutant.When there is a linear relationship between pollutant indicators and health effects, there are interactions among pollutants.Therefore, the following formula is used to give the expression of air microbial contamination detection model:

$$E = \beta * \sum \frac{\alpha y}{a} \tag{2}$$

4 PROTECTIVE MEASURES

Because most of the climbers train outdoors, the air environment has the greatest impact on the quality and effect of sports training.Outdoor is the main place for athletes to do sport climbing, it needs to be planned reasonably, for example, in a place far from the source of air pollution.Athletes'daily training environment is not unchanged, and their environment is difficult to be transformed. Therefore, in the process of sports training, it is necessary to choose sports venues reasonably according to the actual training environment, so as to create a good environment for athletes.

5 DISCUSSION

Climbing exercise cardiopulmonary function test (CPET) refers to the joint measurement and comprehensive evaluation of the subjects'cardiopulmonary function under specific exercise load.This method makes up for many shortcomings of traditional static cardiopulmonary function test, and is a dynamic detection method for comprehensive evaluation of human respiratory and circulatory function.In recent years, CPET has also been included in the scientific evaluation index system of athletes'physical fitness and fitness effect of physical exercise.VO2max and VO2max/kg are important indexes for evaluating the cardiopulmonary function of human body under extreme load. They mainly reflect the maximal capacity of cardiovascular system, respiratory system and muscle to absorb and utilize oxygen in exercise cardiopulmonary coupling link, that is, the overall reserve of cardiopulmonary function and the maximal aerobic metabolic capacity. VO2, VO2/kg, VO2/VO2max are reflected in the actual capacity of the human body to utilize oxygen when there is no sharp accumulation of lactic acid in the body during the incremental exercise load.O2P is the best index to evaluate the efficiency of cardiac oxygen transport. It is related to the output of each stroke and the difference of arteriovenous oxygen. The higher the value of oxygen dioxide P, the higher the efficiency of cardiopulmonary work and the better the function. As an important index for evaluating respiratory efficiency, the smaller the value of EQO 2, the higher the oxygen uptake efficiency.

6 CONCLUSION

Atmospheric environmental quality affects rock climbing and cardiopulmonary functional reserve and maximal aerobic metabolic capacity;The harmfulness of atmospheric environmental quality to the respiratory system of the sports population is obviously greater than that of the general population.It is suggested that when engaging in outdoor physical exercise, the environment with good gout, open space and sufficient sunshine should be chosen to avoid areas with serious air pollution (such as around chemical plants and on both sides of busy streets). People who live in air pollution environment for a long time need to be provided with regular cardiopulmonary function tests. Don’t neglect their health because they exercise regularly.

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