Comparative Analysis of the Influence of Mobile Intelligent Terminal on Human Cardiopulmonary Function in Anaerobic and Aerobic Exercise Training

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In order to understand the impact of mobile smart terminals on human cardiopulmonary function in anaerobic and aerobic exercise training, we study the effects of moderate-intensity aerobic exercise and anaerobic exercise on improving human physical fitness, shape, etc. Measurement and analysis of body composition and cardiorespiratory fitness in humans during moderate-intensity aerobic and anaerobic exercise studies. The characteristics of diversified, emerging, and humanized mobile intelligent terminals have attracted the attention of college students. Mobile smart terminals have brought a lot of convenience to college students’ aerobic and anaerobic fitness. The results showed that people who participated in aerobic exercise and anaerobic exercise were more fit, and their BMI, WHR, and body fat rate were significantly better than those who did not participate in aerobic exercise and anaerobic exercise; at the same time, the lung capacity of people who participated in exercise was significantly higher. Stroke volume, maximum oxygen uptake, ejection fraction, etc., were significantly improved, and myocardial contractility was significantly improved, all better than those who did not participate in the exercise. Therefore, aerobic and anaerobic exercise can help improve a person’s body composition and improve cardiopulmonary function. Therefore, how to give full play to the value of mobile smart terminals in aerobic and anaerobic fitness has become a hot research topic.

1. Introduction

The Telecommunications Research Institute of the Ministry of Industry and Information Technology of the People’s Republic of China released the “Mobile Terminal White Paper” in 2012, pointing out that since 2007, intelligence has caused “genetic mutation” of mobile terminals [1, 2], changing the role of mobile terminals [3] as a mobile network. Traditional positioning of the tip: since 2007, mobile smart terminals [4–6] represented by Apple’s iPhone have gradually replaced traditional mobile terminals [7] and gradually entered a new era of mobile smart terminals. Therefore, the mobile intelligent terminal has undergone a transformative development [8]. Mobile intelligent terminals have gradually become new media, e-commerce, and information service platforms, the most important link between Internet resources, mobile network resources, and environmental interaction resources. Its operating system and processor have reached a strategic level in the entire ICT industry point. The core of mobile intelligent terminals is to provide application services. The biggest feature is entertainment and practicality. With the continuous development of science and technology and Internet technology, its influence has been far greater than that of radio, television, and the Internet, becoming the fourth largest in history. It is a terminal product with wide coverage, rapid popularization, and huge influence.

After decades of gradual development [9], mobile terminal technology has entered the era of intelligent terminals. In 2013, the sales volume of mobile smart terminals exceeded...
that of Internet machines. Under this trend, the related industry structure based on various terminal operating systems has gradually stabilized. Under the background of the rapid development of mobile intelligent terminal technology [10, 11], the use of smartphones, wearable devices, and other mobile terminals for aerobic and anaerobic fitness is more and more popular among college students [12, 13]. Smartphone applications featuring sensitive operation, high brightness, fast Internet access, and long-lasting power are the most popular and widely used. The university stage is an important period for establishing the outlook on life and values and also an important period for forming the habit of physical exercise and the outlook on lifelong sports. Times are changing, society is developing, and the aerobic and anaerobic fitness methods of college students are constantly being updated. Aerobic and anaerobic fitness are facing the challenge of change. In the face of college students who like innovation, fashion, challenges, and following trends, traditional aerobic and anaerobic fitness methods can no longer fully meet their fitness needs.

The cardiopulmonary function generally refers to the physiological process of delivering oxygen and nutrients to the body through the oxygen transport system, through the blood circulation promoted by lung respiration and cardiac activity, so as to meet the needs of various human life activities and energy metabolism. The whole process involves the function of the heart to make and pump blood, the ability of the lungs to take up oxygen and exchange gas, the efficiency of the blood circulatory system to carry oxygen to various parts of the body, and the function of the muscles to use this oxygen. The cardiopulmonary function represents the aerobic work capacity or aerobic metabolism capacity of the human body. Good cardiopulmonary function is the basis for the development of various functions and qualities of the human body. Its quality is directly related to the strength of the human metabolic function and the recovery of the body after exercise. The speed of the function: a large number of studies in sports medicine at home and abroad have proved that the level of human cardiopulmonary function is closely related to health status and exercise capacity. Therefore, the level of cardiopulmonary function is an important indicator to reflect the level of physical fitness of the body. Therefore, detecting and evaluating the cardiopulmonary function of human exercise is an important method to reflect human health. At present, the commonly used dynamic test methods for the assessment of cardiopulmonary function are as follows: Ledunov combined functional test, Harvard step test, bicycle exercise test, and movable platform (treadmill) exercise test. These types of exercise tests mainly focus on the cardiac functional status, and overall cardiopulmonary function was assessed indirectly by estimating VO2max, without direct measurement of changes in gas metabolism.

The State Council’s notice on the “National Fitness Program (2011-2015)” clearly pointed out that “National fitness [14, 15] is closely related to people’s physical health and life happiness, and is an important symbol of comprehensive national strength and social civilization progress. It is an important part of the construction of socialist spiritual civilization and an important part of building a well-off society in an all-round way.” The outline of the “National Fitness Plan” pointed out that “physical exercise” [16] is the key means to achieving national fitness, and it is the key to improving the quality of the people. Among the many factors, affecting physique is the most positive, effective, obvious, simple, and easy-to-follow and important means. Physical exercise can improve the physical fitness of the people, and it can also bring economic benefits to the society, form a healthy and civilized lifestyle, and also play an important role in cultivating good moral quality. At present, the implementation of the outline of the “Comprehensive Fitness Program” is positive covering all parts of the country, the key to the development of national fitness [17, 18], and the benefits of fitness lies in people’s awareness of participating in fitness. As the hope of the motherland and high-level talents in the 21st century, on the one hand, one must have profound knowledge, and on the other hand, they must have a strong physique, in order to better serve the motherland, serve the society, and serve the general public. Colleges and universities at all levels must fully advocate the physical education policies promulgated by the state, paying attention to the school’s physical education work, paying close attention to the physical and mental health and physical health of college students, and cultivating college students’ lifelong sports outlook. Regular participation in physical exercise not only has a positive impact on college students’ physical health [19], physical fitness, and sports skills but also can improve and develop college students’ intelligence, cultivate their sentiments, hone their will, etc., and also help to cultivate college students’ lifelong sports awareness. In addition, in the comprehensive development of college students’ morality, intelligence, physical beauty, labor, implementation of the national fitness plan, and accelerating the formation of a harmonious society. It will have a certain degree of positive impact. Therefore, this paper uses mobile smart terminals as a medium to study the fitness status of aerobic and anaerobic fitness. The diversified, emerging, and humanized characteristics of mobile smart terminals have an impact on college students’ aerobic and anaerobic fitness. Aerobic fitness has the role of guiding, promoting, and supervising. By studying the application of aerobic and anaerobic fitness of mobile smart terminals and putting forward corresponding development countermeasures according to actual problems, people can be guided to exercise correctly and form good aerobic fitness. With anaerobic fitness awareness and correct aerobic and anaerobic fitness behaviors, a certain foundation is laid for the improvement of people’s physical fitness and health status.

With the popularization of smartphones and the increasing attention to healthy life [20, 21], other personal health and exercise monitoring devices and mobile phone applications based on sensor behavior recognition are also emerging one after another. For example, the human motion data are collected by the three-axis accelerometer embedded in the smartphone and uploaded to the server for processing and identification. Users can view the motion behaviors identified by the software within a certain period through the Web, including walking, running, and lying down. The
experimental data show that its recognition accuracy can reach 82%–95%; the early domestic cooling movement can monitor the duration of different movements of the user, track the movement route through the GPS function [22, 23], and calculate the exercise distance, speed, number of steps, and energy consumption; as a wearable health monitoring device, the Xiaomi Mi Band can not only check the amount of exercise in real-time through the mobile app but also count the steps of walking and running, as well as the user’s health monitoring. Sleep status and quality are monitored and analyzed.

### 2. Related Technologies

With the increasingly powerful functions of smartphones, sensors have also become the nerve endings of smartphones, which can obtain information about the surrounding environment and users in a timely and accurate manner and also provide a platform for smartphone-based human motion recognition technology. At present, sensor-based human behavior recognition mainly adopts the method of statistical pattern recognition. This chapter will focus on the acquisition of common sensors and sensor data on android smartphones, as well as the theoretical basis and processing flow required for human motion recognition.

#### 2.1. Smartphone Sensors

Today’s smartphones not only have the increasingly powerful computing power and convenient human-computer interaction but also add a variety of sensors. Mainstream smartphones are generally equipped with a three-axis accelerometer, gyroscope, fingerprint recognition sensor, light sensor, and distance. There are many different types of sensors. Table 1 gives a brief introduction to the current sensors on smartphones. These sensors can detect signals such as light, temperature, and magnetic fields in the environment, as well as various user operations and motion states. For example, a smartphone can automatically adjust the brightness of the screen by recognizing the intensity of the outside light through the light sensor. When the user is talking, the distance sensor will turn off the screen when the phone is close to the ear, and the user can easily unlock the screen through the fingerprint sensor. Thanks to the built-in sensors of the smart hand, the user’s operations are more convenient.

In the research of sensor-based human motion recognition, the most commonly used acceleration sensor is the acceleration sensor generally used in smartphones. The unit of data is m/s², which includes the influence of the current gravity. When the mobile phone is in a stationary state, the resultant acceleration on the three axes is equal to the gravitational acceleration, and the current posture of the mobile phone can be estimated by the components of the gravitational acceleration on the three axes. Another motion-related sensor in a smartphone is a linear acceleration sensor, which measures the acceleration of the phone in three-dimensional space after excluding the current gravity. It is a synthetic sensor. The difference between the acceleration sensor and the linear acceleration sensor is only whether the output measurement value includes gravity data, and whether the spatial coordinate system used by the two is the same.

An accelerometer is a kind of inertial sensor, which is usually composed of a measurement circuit, sensitive element, and conversion element. Among them, the capacitive sensor is based on the principle of capacitance. Under the action of acceleration, the movable elastic diaphragm electrode will be displaced, so that the capacitance changes accordingly, and the acceleration value is obtained through the peripheral measurement circuit. With the advantages of high sensitivity, high precision, small size, and low power consumption, it is widely used in mobile phone mobile devices and car airbags. And when the accelerometer is stressed, the force on the piezoelectric element changes at the same time. When the vibration frequency of the object is far less than the natural frequency of the accelerometer, the change in the force on the piezoelectric element is proportional to the acceleration of the measured object; piezo resistance. The structure of the type sensor is similar to that of the piezoelectric type. The resistance value of the diffusion resistor changes with the magnitude of the acceleration, and the current acceleration value is detected according to the change in the output voltage. Due to its small size and low power consumption, it is used in equipment vibration monitoring, test instruments, automobile crash experiments, and other fields; servo accelerometers are closed loop test systems with dynamic feedback, so they have high anti-interference performance, high measurement accuracy, and large dynamic range, so they can be used in inertial navigation, inertial guidance systems. It is widely used in fields such as high-precision vibration measurement.

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**Table 1: Sensors on smartphones.**

<table>
<thead>
<tr>
<th>Designation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Triaxial accelerometer</td>
<td>Measure the acceleration of a device in three dimensions, including gravity</td>
</tr>
<tr>
<td>Gyroscope</td>
<td>Measure the rotation angle of the equipment about the x, y, and z axes</td>
</tr>
<tr>
<td>Light sensor</td>
<td>Detect the intensity of ambient light</td>
</tr>
<tr>
<td>Range sensor</td>
<td>The nearest neighbor degree of the detection object relative to the mobile phone screen is generally within 10 cm</td>
</tr>
<tr>
<td>Magnetic field sensor</td>
<td>Detect magnetic field changes in the surrounding environment</td>
</tr>
<tr>
<td>Fingerprint sensor</td>
<td>Collect user fingerprint information</td>
</tr>
<tr>
<td>Temperature sensor</td>
<td>It can detect the temperature change of the phone’s chip and battery, as well as the ambient temperature</td>
</tr>
<tr>
<td>Air pressure sensor</td>
<td>Measure the total pressure of a gas in the environment</td>
</tr>
<tr>
<td>Ultraviolet sensor</td>
<td>Monitor the UV index in the environment</td>
</tr>
</tbody>
</table>
The smartphone used in this experiment is Samsung GT-I9508, Android 4.3 version operating system, the built-in three-axis accelerometer model is STMicroelectronics SK330 three-axis accelerometer, the maximum range is 19.6 m/s², and the resolution is 0.00059 m/s². Considering the system power consumption and computational complexity, the human motion recognition research in this paper only uses the three-axis acceleration sensor on the Android smartphone, so the experimental scheme mainly collects acceleration sensor signals closely related to human motion.

2.2. Android Platform Data Acquisition

2.2.1. Android Platform Overview. The Android operating system is an operating platform based on the Linux kernel, and the source code is open. The Android parallel environment provides developers with a large number of API libraries to access system programs. The Android system adopts a layered architecture. Its structural system is shown in Figure 1. From the highest layer to the lowest layer, it is the application layer, the application framework, the system runtime library, and the Linux kernel. The functions of each layer are briefly introduced as follows:

(1) Application layer: Android application layer is composed of all applications running on Android devices, such as calling programs, SMS text messaging programs, browsers, contact management, etc., as well as various third-party applications. All applications can call the classes and services provided in the application framework.

(2) Application framework: the development of Android applications is realized through the interaction between the program framework and the bottom layer.

(3) System runtime library: this layer includes the function library and Android operating environment. The function library has various C/C++ libraries, which are provided to different components of the Android system. The commonly used libraries are the media function library, appearance management function library, OpenGL Graphics library, SQLite database, SGL, etc. Android runtime environment includes core function library and Dalvik virtual machine. The core library has most of the functions of the Java programming language core library. The virtual machine can support multiple virtual systems simultaneously and efficiently run.

(4) Linux kernel: Android uses Linux 2.6 as the core of the entire operating system. The main system services provided by Linux include power management, process management, security management, memory management, network protocols, and driver models.

2.2.2. Sensor Data Collection. At present, smartphones based on the Android platform are equipped with acceleration sensors. At the same time, due to the open-source characteristics of the Android platform, it is very convenient to collect and store acceleration sensor data by writing data acquisition programs. So, the acquisition of sensor signals under the Android smartphone platform is the first step of this research. At the same time, the accuracy of the original...
2.3. Human Motion Recognition Process. A human motion recognition system based on an acceleration sensor usually includes motion data collection and preprocessing, feature extraction, feature selection, and classification and recognition, and its general processing framework is shown in Figure 2:

(1) Data collection and preprocessing: since the sequence of the raw data signal collected by the sensor is very long and contains various noises, it is necessary to perform preprocessing such as windowing, denoising, filtering, etc., on the raw signal data. Among them, windowing is to divide the original signal into fixed time segments to facilitate subsequent feature extraction, while denoising and filtering are to eliminate the influence of noise in the original data to make the signal smoother, and at the same time, it can filter out the gravitational acceleration component. This can affect the prominence of human motion acceleration.

(2) Feature extraction: the preprocessed acceleration data are still a time-based signal sequence, and the motion state cannot be directly identified by the classification algorithm. Therefore, it is necessary to obtain the information reflecting the differences between different motion types through feature extraction, so that the classification and identification can be carried out quickly and effectively. Feature extraction is used to obtain feature vectors describing human motion behavior, which are used as the input of the classification model for model training.

(3) Feature selection: the original signal is converted into a set of feature vectors representing different movements of the user through feature extraction, and then a specific feature selection algorithm is used to perform subsequent processing on the extracted feature vectors. The feature selection process can remove redundant features and improve the recognition rate of system classification.

(4) Classifier training: the core of motion recognition is the training process of the classifier. The training set usually used is the feature set that has marked the motion category, the classification algorithm is supervised to learn the feature information of different categories, and the classification model is generated after a large number of sample training.

(5) Classification and identification: in the recognition stage, the trained classification model can predict the corresponding motion behavior for the input unknown category data, that is, the recognition result is obtained.

3. Research Methods

3.1. Documentation Method. Through the library, we have consulted a large number of related books on lung function and the effect of aerobic exercise on lung function in recent years, as well as the full-text database of Chinese journals, the full-text database of Chinese excellent doctoral and master's dissertations, and the full-text database of Chinese journals in CNKI. The literature data searched from the full-text database of important conferences and the full-text database of important Chinese newspapers are summarized, its theoretical essence is summarized, and some useful contents are cited, which provides a theoretical basis for writing the paper.

3.2. Experimental Method

3.2.1. Experimental Subjects. The research object of this paper is a total of 60 middle-aged people in Xi'an City, Shaanxi Province. Subject requirements: physical health, no major diseases such as cerebrovascular, no genetic history, not taking any drugs that affect the experimental results...
during the test period, voluntarily participating in a 4-month exercise intervention, and actively cooperating to complete all tests.

Table 2 reflects the basic information of 60 people who exercised irregularly in Xi’an. The 60 middle-aged men who exercised irregularly were divided into two groups on average. Among them, 30 participated in the exercise intervention of fitness running, and the other 30 participated in the exercise. Spinning exercise intervention: through the comparative analysis of the data of the two groups of subjects, it is concluded that the significance level is $P > 0.05$, and there is no significant difference. Regular exercise intervention can be carried out in this group.

### 3.2.2. Test Indicators and Precautions

(1) **Test Indicators FVC.** Forced vital capacity refers to the amount of air that can be exhaled after a maximum inhalation and exhale as quickly as possible:

- **FEV1**: the maximum exhalation is performed after the maximum deep inhalation. The volume of the exhaled air volume in the first second of the maximum exhalation is the forced expiratory volume in one second, which is called the one-second volume.
- **FEV1%**: FEV1/FVC ratio.
- **FEF25-75% (L/s)**: the expiratory interruption flow rate, that is, the average flow rate in the interval of 25%–75% of the vital capacity when the expiratory volume is forced to exhale.
- **FEF25% (L/s)**: the instantaneous flow rate in the pre-breathing period, that is, the maximum expiratory flow rate at 75% of the vital capacity.
- **FEF50% (L/s)**: the instantaneous flow rate in the mid-breathing period, that is, the maximum expiratory flow rate at 50% of the vital capacity.
- **FEF75% (L/s)**: the instantaneous flow rate in the late stage of breathing, that is, the maximum expiratory flow rate at 25% of the vital capacity.

(2) **Indicator Test Frequency.** One week before the exercise intervention, the relevant indicators were tested, and one week after the exercise intervention, a total of 2 tests were conducted.

(3) **Precautions.** The subjects took the standing position and clamped the nose with a nose clip to ensure that the bilateral nostrils were not leaking. The mouthpiece is fully inserted into the mouth (make sure no gas leaks out of the mouth). After starting a few natural breaths in a calm state, slowly inhale as much air as you can, and then exhale all the air as quickly as possible (as you exhale, try to bend over as much as possible to help the air out of the lungs as much as possible), followed by deep inhalation as soon as possible. Repeat the spirometer three times to automatically select the best result, and take the best test result for recording:

1. Use a 3-liter volume syringe for calibration
2. The mouthpiece is a disposable consumable and should be compatible with the pulmonary function tester
3. Professionals are responsible for explaining and telling the subjects how to breathe before the test
4. The test results are printed on thermal paper, and the subject number and name are marked on the thermal paper

### 3.3. Data Processing

This research uses the relevant knowledge of mathematical statistics and uses SPSS17.0 statistical software and Microsoft Excel 2003 software to carry out statistics and analysis of the data obtained in the experiment. All data are expressed as mean ± standard deviation ($\bar{x}$ ± s), and the comparison between related experimental data was performed by paired-sample T test for statistical analysis, with a significance level of $P < 0.05$ and $P < 0.01$ as a very significant difference standard.

### 4. Experiments

The effects of aerobic and anaerobic exercise on cardio-pulmonary function were studied by means of a literature review and expert interviews. It is concluded that aerobic exercise can improve cardiopulmonary function. After group training for the experimental group and the control group, the cardiopulmonary function of the experimental group after eight weeks of aerobic exercise training can be significantly improved, which is comparable to the anaerobic training of the control group. In comparison, the two may be relatively close to the changes in the indicators.

Before the experiment, the cardiopulmonary function indicators of the research subjects were measured in advance, and the resting heart rate, maximum vital capacity, and step test index of the three groups (A, B, and C) were statistically sorted. As well as the experimental subjects in the normal observation group, the conditions are similar and have small differences, and the independent sample T test is used to illustrate the situation.

Table 3 shows the results of resting heart rate, maximum vital capacity, and latter-order experimental index of students in experimental (group A) and control (group B) groups.

Note: there is a significant difference when $P < 0.05$, and there is no significant difference when $P > 0.05$.

### Table 2: Basic information of subjects ($\bar{x}$ ± s).

<table>
<thead>
<tr>
<th>Group</th>
<th>Average age (y)</th>
<th>Average height (cm)</th>
<th>Average weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jogging ($n = 30$)</td>
<td>52.11 ± 4.82</td>
<td>170.11 ± 5.05</td>
<td>71.10 ± 8.58</td>
</tr>
<tr>
<td>Spinning ($n = 30$)</td>
<td>51.91 ± 4.82</td>
<td>170.30 ± 5.10</td>
<td>72.30 ± 10.38</td>
</tr>
</tbody>
</table>
Through the sample test of their resting heart rate, maximum vital capacity, and step test index of the experimental group and the control group, it can be concluded that the resting heart rate $P$ values of the experimental group and the control group were 0.835, respectively, and the $P$ value was greater than 0.05, indicating that there was no significant difference in the resting heart rate of the players in the experimental group and the control group.

The $P$ value of the step test index between the experimental group and the control group was 0.708, and the $P$ value was greater than 0.05, indicating that there was no significant difference in the step test index between the experimental group and the control group.

Through the sample test of their resting heart rate, maximum vital capacity, and step test index of the experimental group and the control group, it can be concluded that the resting heart rate $P$ values of the experimental group and the control group were 0.835, respectively, and the $P$ value was greater than 0.05, indicating that there was no significant difference in the resting heart rate of the players in the experimental group and the control group. There is no significant difference in the aspects.

The maximum vital capacity $P$ value of the experimental group and the control group was 0.997, and the $P$ value was greater than 0.05, indicating that there was no significant difference in the maximum vital capacity between the experimental group and the control group.

The $P$ value of the step test index between the experimental group and the control group was 0.708, and the $P$ value was greater than 0.05, indicating that there was no significant difference in the step test index between the experimental group and the control group.

To sum up, the cardiopulmonary function of the experimental group and the control group was basically at the same level, and there was no significant difference.

5. Conclusion

Healthy and scientific aerobic exercise [24, 25] is extremely beneficial to improving the cardiopulmonary function of young people. At present, there is relatively little research on real-time monitoring and evaluation of fitness exercise using
scientific methods and means of exercise physiology at home and abroad. Therefore, using the cardiopulmonary function exercise test to find the appropriate load for aerobic and anaerobic exercise through dynamic monitoring of physiological and biochemical indicators during aerobic exercise and anaerobic exercise can make the research results more practical. Therefore, we perform dynamic detection on these two kinds of motion, hoping to contribute to the research in this area.

Data Availability

The dataset can be accessed upon request to the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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