

# The Effect of Musical Stimulation in Sports on Sports Fatigue of College Students

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## Abstract

Exercise fatigue refers to a physiological process in which the body's ability to exercise or work efficiency decreases and cannot be maintained at a specific level. Music therapy, as a new frontier discipline integrating psychology, music and therapy, has attracted wide attention from all walks of life. Music also increases the excitability, activity and mood of neurons in the cerebral cortex. In this paper, the role of music in promoting aerobic exercise fatigue recovery is carefully explored. It compares and evaluates the efficacy of passive music therapy and music electrotherapy from different levels. And try to explore the mechanism of music therapy from the new perspective of central neurotransmitter. In the future, you can listen to music while exercising and explore the time of exercise for low cardio endurance college students. Further explore the sports music department for low cardiopulmonary endurance students. Provide a more complete theoretical basis for future research work, and lay a solid foundation for the development of scientific sports music prescriptions.

**Key words:** Exercise fatigue, Music therapy, Exercise ability, Sports, cerebral cortex, Training, biomechanical characteristics

## 1 Introduction

Exercise fatigue refers to a physiological process in which the body's ability to exercise or work efficiency decreases and cannot be maintained at a specific level. Exercise fatigue is mainly manifested in the decline of exercise ability [1]. Long-term training under fatigue condition will also lead to sports injuries, seriously affecting the improvement of sports ability. Therefore, sports fatigue is an eternal theme in the field of sports medicine and sports training [2]. Music therapy is a kind of treatment technology which integrates medicine, psychology, music aesthetics, physics and other disciplines, and uses specific music to change people's behavior, feelings and physiological functions. Music therapy integrates physiological functions which helps to manage or reduce stress and it helps to

improve the functioning. Listening music releases pleasure causing matter in brain increasingly, enrich neural network functioning, improves body immune system. Thus this type of therapy treats psychological, cognitive, social and physical illnesses of patients. [3]. Modern music therapy mainly includes passive music therapy which mainly listens to music and active music therapy which mainly participates in music activities. Fitness and athletes also often listen to music during exercise training to relieve the boring, monotonous and tired feelings of long-term exercise [4]. The combination of music and exercise is not only manifested in the process of sports training, but music as an auxiliary treatment also plays an active role in promoting the recovery of exercise fatigue after exercise training [5]. At present, music therapy as a new frontier discipline integrating psychology, music and treatment has received wide attention from all walks of life.

Musical Stimulation in Sports can enhance the performance of athletes which will delay fatigue or else improve the capacity of work or delay and leads to higher expected endurance, strength, power and many more. However, the athlete's performance is enhanced by music and it stimulate that brain part is even responsible. There are two kinds of speculations on the mechanism of music stimulation to prolong exercise time: First, music reduces mental fatigue and delays the generation of physical fatigue to prolong exercise time [6]. Second, the music is pleasantly stimulating, and may block the upward conduction of the physical stimulation reaction, which is a bad stimulus, to prolong the exercise time. Music can be transmitted to the human body through the auditory organs, and subtle and harmonious synchronous vibration occurs [7]. Music can also increase the excitability, activity and mood of the cerebral cortical nerve cells. Music stimulates the cerebral cortical nerve cells by the simulation of exact cerebral circuits. By listening music, the neurotransmitter dopamine is increased. However, dopamine is a vital part of pleasure reward system and motivation molecule of brain. It incorporates the area of cortical illustration on the way music affects. Numerous studies have shown that music has a positive effect on improving bad mood [8].

Music has been widely used in the research field of sports fatigue. At present, the research in this field has not involved the effect of music on the fatigue of skeletal muscle, cardiovascular and nervous system caused by exercise while reducing the sense of fatigue. In this context, this paper focuses on the low cardiopulmonary endurance College students, and applies the theoretical knowledge to the low cardiopulmonary endurance College students [9]. Through the experimental method, low cardiopulmonary endurance college students without music preference were tested to explore the similarities and differences of exercise fatigue indicators under different types of music and different intensity exercise.

Music therapy has good psychological regulation. It relieves tension and improves mental state through empathy, suggestion and induction. It can also alleviate pain and improve the language and cognitive ability of dementia patients [10]. In addition, music therapy can also reduce heart rate, blood pressure and enhance the body's immune function. The application of music in different periods of exercise will have a specific impact on people's physiology and psychology [11]. Music can improve athletes' mood, improve sports ability, speed up the mastery of motor skills, reduce the subjective fatigue feeling in intensity exercise, and enhance the training effect. Listening to music before exercise can improve athletes' bad mood [12]. Sports is a purposeful and conscious activity [13]. The emotional changes of athletes before the game will be directly reflected in the game. The more intense the competition, the more obvious the athlete's psychological activity [14]. This article carefully explores the role of music in promoting aerobic exercise fatigue recovery. It compares and evaluates the efficacy of passive music therapy and music electrotherapy from different levels. And try to explore the mechanism of music therapy from the new perspective of central neurotransmitter. The research results can provide a detailed and reliable and highly valuable experimental basis for the application of music therapy in the field of exercise fatigue recovery. The evaluation of cardio endurance college student helps to improve cardiovascular health, reduce asthma and chronic pain, supports immune system, lowers blood pressure and this evaluation is also beneficial for lung cancer and heart disease. Thus the cardiovascular exercise supports for healthy body composition maintenance.

This article carefully explores the role of music in promoting aerobic exercise fatigue recovery. It compares and evaluates the efficacy of passive music therapy and music electrotherapy from different levels.

In summary, our contributions are as follow:

1. This algorithm is a new therapy based on sports music stimulation for college students' sports fatigue.
2. The article proposes a new model for students' sports fatigue.

3. The therapy has a good effect in the recovery of exercise fatigue, and has high applicability for most of the problems of sports fatigue recovery.

While listening music an individual to recorded or live music is considered as passive music therapy because of no active participation or music engagement. This passive music therapy comprises active intervention, tracks of recorded listening series based on the rhythmic pulse at a constant. It is concurrence with active MT by lively music making in order to evaluate whether the physiological correlates. In general, electrotherapy is the one of the medical treatment by an electrical energy use, however music electrotherapy works on the electro-acupuncture basis by combining electrode and music with an electro acupuncture.

## 2 Related Work

Listening to music before exercise can improve the speed and endurance of exercise. Durcan L and others take children, young people and the elderly as the research objects. After listening to 1 minute of fanatical music, soft music and blank noise, the subjects in each group immediately took 2 minutes of power bicycle exercise, and the faster the bicycle speed, the better [15]. The results showed that children and young people in both age groups performed better after listening to manic music and soft music than after listening to blank noise. Paul L. et al. studied the influence of music stimulation on aerobic ability of juvenile volleyball players at the national level during warm-up exercise. The results showed that after warm-up exercise in music environment, the anaerobic threshold of athletes increased [16]. José et al. studied the similarities and differences in emotional aspects of advanced cancer patients with music intervention [17]. The experimental results show that the treatment of foot massage under the intervention of music can help cancer patients to alleviate the bad feelings such as anxiety and anxiety caused by isolation and illness. In turn, it helps the family and patients to communicate in time and improve the quality of treatment.

An experimental study by Bachasson D et al. showed that prostate patients who received music intervention before surgery had a significantly lower degree of emotional irritability, heart rate, and blood pressure than patients who did not listen to music before surgery [18]. It can be seen that listening to music before surgery can effectively alleviate the negative emotional state such as preoperative eschar. Ching-I L et al. showed that the children's listening to music can effectively improve their emotional symptoms such as anxiety and improve their comfort through the correlation experiments on cancer children [19]. In addition, Miller R G and other subjects stimulated the classical and heavy metal music to explore the emotional impact of music on the subjects

[20]. The experimental results show that classical music plays a significant role in reducing adverse emotions such as irritability and inducing positive emotions. However, this scientific sports music prescription which presented in our research study helps college students to explore suitable exercise time for with low cardiopulmonary endurance and make them more active in physical exercise and achieve better exercise effect.

### 3 Materials and Methods

Music is a series of tones that change with the rhythm and is the natural expression of human emotions. Music therapy has a long history. It is only because of the lack of attention and research that it has not been able to form a systematic theory for a long time. Traditional music therapy has a long history, and the theory of five-tone therapy is still shining. Just because of historical reasons, modern music therapy has not been fully developed. Although it started late, it has developed very rapidly [21]. The music emotional response questionnaire is used to determine the tester's

music perception to ensure that the tester can have a correspondingly good psychological impact on the different types of music during the experiment. Numerous studies in sports psychology and physiology have shown that music has made important advances in the application of exercise fatigue [22]. Music can reduce the subjective fatigue feeling in low- and medium-intensity sports, and music plays an important role in promoting the recovery of sports fatigue. However, while music stimulation reduces subjective fatigue, whether exercise-induced fatigue in skeletal muscle, cardiovascular and nervous system can also be alleviated. In this state, the listener will feel calm and relaxed, and can induce a kind of brain wave that makes people fall into a meditative state. It can make physical activity with the rhythm of music, the spirit will become relaxed.

The classification of sports fatigue can be divided into rapid and endurance sports fatigue according to the different ways of sports and the duration of continuous sports activities. Figure 1 shows changes in levels of important metabolites when potential metabolic pathways are disrupted.

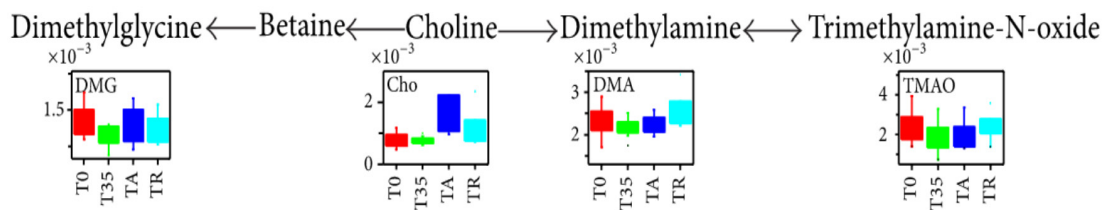


Figure 1. Changes in the levels of important metabolites

In the process of sports training, the diagnosis of exercise fatigue is completed by the coordination of coaches and athletes. It is an important part of the scientific training program to select appropriate and simple methods to scientifically diagnose the occurrence and extent of fatigue of athletes. 30 sports team athletes were invited to participate in the experimental test. The basic data of the athletes are shown in Table 1.

Table 1. Basic data of athletes

Gender	Number	Age	Height (cm)	Weight (kg)
Male	15	18±1.25	178±0.86	68±2.35
Female	15	18±2.46	161±0.99	49±3.15

Music can produce psychological activities such as association or imagination. So we can improve the bad mood and regulate the abnormal mental state by empathy, sustenance, suggestion and induction. Listening to regular music during exercise tends to make the body move in accordance with this rhythm. It is helpful to increase the secretion of beneficial substances and induce positive emotions in the body, so that the subjective feeling of exercise is good and the endurance of exercise is enhanced. The higher the

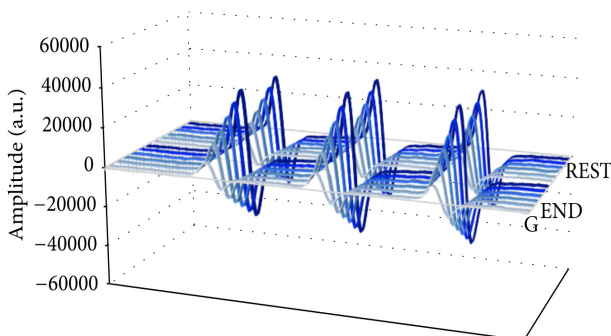
score of vigor stimulation, the more vigorous it is. The higher the score of positive involvement, the more involvement in sports. The higher the score of physical and mental calmness, the calmer it is, and the lower the score, the greater the emotional fluctuation. The higher the physical fatigue score, the more severe the fatigue. Music therapy also has a certain physiological regulation [23]. Listening to relaxing music can slow down your heart rate and lower your blood pressure, which will help you recover from cardiovascular and cerebrovascular diseases and reduce complications. The beat of the music is about twice the speed of the power bicycle, which is consistent with the motion rhythm of the subject, which helps to stimulate the good mood of the subject during exercise. Music therapy is efficient for clinical use to improve the quality in life. Before music therapy there is a physical discomfort, stress, negative side effects and many more. However, after music therapy, this therapy helps to reduce heart rate, depression, psychological disorders symptoms, tension, lower blood pressure, improve cardiac output and so on. In the experiment, three popular music types were selected according to the common wishes of the subjects. The selection of music is shown in Table 2.

**Table 2.** Music type selection

Music type	Beat	Time
Pop music	131.16	31 minutes and 16 seconds
National music	130.45	30 minutes and 58 seconds
Rock music	129.78	31 minutes and 29 seconds

The psychological and physiological regulation of music is based on a large number of complex neurophysiological activities. Musical stimulation first acts on the auditory receptors in the cochlea. The vestibular cochlear nerve is transmitted to the dorsal and ventral cochlear nucleus of the medulla, and then transmitted from the hypothalamus to the medial geniculate nucleus. Eventually arrived at the listening area located in the temporal cortex of the cccc. Compared with before exercise, the number of errors in the selection reaction after exercise increased significantly, that is, there was a statistically significant difference in the comparison within the group. However, there is no interaction between the test timing and the grouping factor. There was no significant difference in the number of errors in the selection of reactions between the groups. Exercise can cause changes in the function of the circulatory system. Mainly manifested in causing sympathetic excitation, causing visceral vasoconstriction, increased circulating blood volume, increased heart rate, and elevated blood pressure. The heart rate of the subjects during the recovery period of 10 minutes was measured immediately after the end of each index test in the experiment. The heart rate value was recorded once a minute, and the final result was taken as the average. Blood lactic acid refers to anaerobic metabolism due to excessive exercise, which exceeds the intensity of aerobic exercise, resulting in insufficient oxygen supply. This leads to the formation of blood lactic acid that cannot be decomposed into water and carbon dioxide in time and accumulated in large quantities in the body.

The signal amplitude in the final exercise test decreased compared with that in the predictive test. The spectrum overlap recorded before and after training at rest and at the end of exercise is shown in Figure 2.



**Figure 2.** Spectrum overlay image recorded at rest and end of exercise

In the process of detecting and assessing the athlete’s body biochemical indicators, the model parameter identification assumes a data observation point. The model is:

$$EI \frac{d^4 y(x)}{dx^4} - GB \frac{d^2 y(x)}{dx^2} + KBy(x) = 0 \tag{1}$$

Make the output of the model best predict the output of the system and obtain an estimate of the parameter:

$$E = \frac{t_m + t_u}{(t_m / E_m) + (t_u + E_u)} \rho \tag{2}$$

$$y = \frac{4f}{l^2} x(l-x) + \frac{h}{l} x \tag{3}$$

The formula for calculating the integral my electricity is:

$$f = \frac{qI^2}{8H} = \frac{(wS_0)l}{8H} \tag{4}$$

The human body system model provides a tool for studying human biomechanics, increasing the scope of human biomechanics research. Model parameter identification assumes that a data observation point is obtained. The model is:

$$f = \min \sum_{i=1}^n (\Delta \hat{t}_{ij} - \Delta t_{ij})^2 = \min \sum_{i=1}^n \left( t_i - t_j - \frac{l_i - l_j}{v} \right)^2 \tag{5}$$

In sports training, the characterization model of the joint proprioception with time can be represented by a polynomial function:

$$f = \min \left\| (t_i - t_j)v - (l_i - l_j) \right\| \tag{6}$$

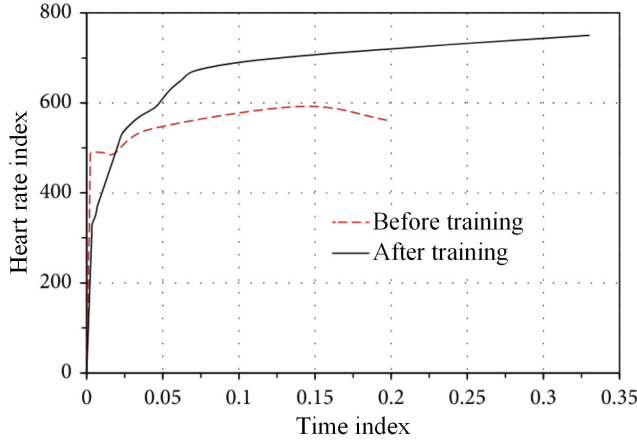
Functional recovery refers to the process in which the human body function and energy substances return to and exceed the pre-load level by the state of temporary decline and decrease after the load. Heart rate index is a vital parameter for calculating the cardiac effects and for parasympathetic activity it is a straight indicator. It defined as the decrease in heart rate at peak level, after stress test it is observed via the cool down period. Heart rate is used to assess athlete fatigue. The changes in heart rate before and after training are shown in Table 3 and Table 4. The heart rate comparison before and after training is shown in Figure 3.

**Table 3.** Changes in heart rate before training

Gender	Immediately	1min	2min	3min
Male	79.1	81.2	79.6	81.5
Female	76.8	80.1	78.4	79.8

**Table 4.** Heart rate changes after training

Gender	Immediately	1min	2min	3min
Male	181.2	174.1	129.6	119.2
Female	177.5	175.6	131.2	116.8



**Figure 3.** Heart rate comparison before and after training

### 4 Result Analysis and Discussion

The fatigue of skeletal muscle system is also an effective method to evaluate exercise fatigue. As the muscle attached to the skeleton decreases in strength during fatigue, the muscle cannot relax effectively and the elasticity decreases, resulting in the phenomenon of muscle stiffness. The introduction of music as a pleasant stimulus can usually be prioritized by the brain. To a certain extent, it blocked the upstream conduction pathway of adverse stimuli such as pain, thus further enhancing the analgesic and emotional effects of music. The heart rate of each group increased significantly after exercise. Although the heart rate after exercise was significantly lower than that immediately after exercise, it was still significantly higher than the quiet level. It shows that aerobic treadmill exercise has resulted in heart fatigue and decreased heart rate regulation function. Generally speaking, the reaction time refers to the whole process from the start of receiving the signal stimulation to the reaction. The diagnosis of blood lactate is a common indicator in the study of exercise. During exercise, a large accumulation of blood lactic acid can cause local soreness in the muscles of the subject, which in turn affects the exercise effect. The test results at the time of the reaction are mainly affected by factors such as the attention of the tester, fatigue, and differences between individuals. Therefore, the tester must maintain a high degree of concentration before testing to ensure the validity of the data.

In the actual analysis process, it is only necessary to obtain joint active activity measurement data under several training intensities. The corresponding joint flexion activity and the activity of varus and eversion

in the dynamic equilibrium state can be obtained:

$$\frac{\gamma HF}{C_{u0}} = A + \frac{\rho HF}{C_{u0}} B \tag{7}$$

Timely understanding of athletes' fatigue and recovery after training is the result of training and competition. The performance plays a decisive factor. Make the output of the model best predict the output of the system and obtain an estimate of the parameter:

$$E[C(t_1)] = C_1 + \sum_{t=1}^{t_1} \left[ \frac{E[C_M(t)] + E[C_R(t)]}{(1+r)^t} \right] \tag{8}$$

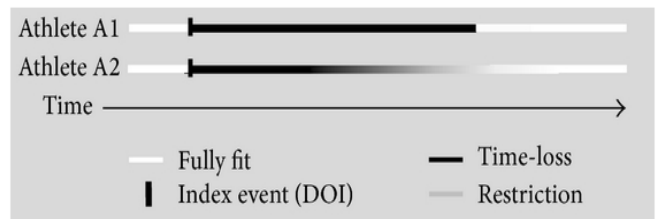
The formula for calculating integral EMG is as follows:

$$E[C_R(t)] = \sum_{j=1}^J \sum_{k=1}^K P_{j,k}^f(t) n_j c_{R,j} \tag{9}$$

The average torque index is a level of torque which is maximum by diverse movement of composite shoulder-girdle for various sport type. Based on the obtained muscle impact model under exercise training, the torque acting on each joint is inversely determined:

$$P_{j,k}^f(t) = \phi(-\beta_{j,k}(t)) \tag{10}$$

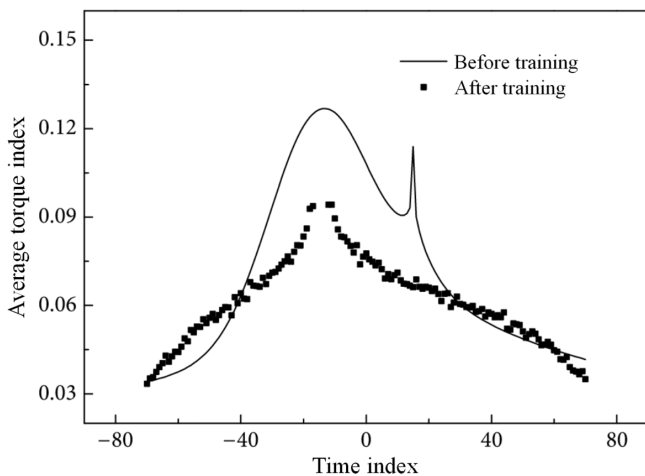
After the athletes are tired, they do not take a rest to eliminate fatigue. Instead, the content of the training is changed in a timely and scientific manner, and the load of the training is adjusted, and the part of the movement is changed as a rest. In order to achieve the purpose of eliminating fatigue. The traditional definition of time loss includes the classification of sports injuries and changes in damage status. The change in damage state is shown in Figure 4.



**Figure 4.** Change in damage state

Some scholars explore the mechanism of music therapy from the perspective of physics and put forward the hypothesis of resonance principle. The theory holds that music is a sound wave that has its own energy. Information can be conveyed through tune, rhythm, melody, strength, speed and other factors. The reaction time is an important variable for evaluating human activities. It is one of the most commonly used indicators of psychological activity in psychophysiological experiments and one of the indicators of nervous system fatigue. In the experiment, when the test subjects immediately reacted after exercise, the number

of tests per reaction after each exercise was twice, and the results were averaged. The rate of decline in heart rate during recovery can directly reflect the level of exercise fatigue [24]. In the experiment, the heart rate of all subjects during recovery period was monitored, and the mean heart rate was recorded as an index of heart rate during recovery period. The selection of music, volume control, treatment time, treatment environment and other aspects of music therapy are still lack of detailed requirements and norms, which to some extent affects the therapeutic effect of music therapy. Music is selected based on the musical preferences of an individual which creates peaceful environment and relaxing. However, the treatment timeline is based on treatment through music creation by both client and therapist, which lead to active participation. Also MT provides treatments to treat individuals with illnesses, injuries, disabilities. MT cover annoying auditory stimuli, stimulate cool environment in order to reduce problems or failure. Statistical results of various mechanical indexes before and after training are given. The experimental results are shown in Figure 5.



**Figure 5.** Comparison of average muscle strength between knees before and after training

Extract the biomechanical characteristics of muscle meat under different training stages and obtain the muscle exercise state in different training stages:

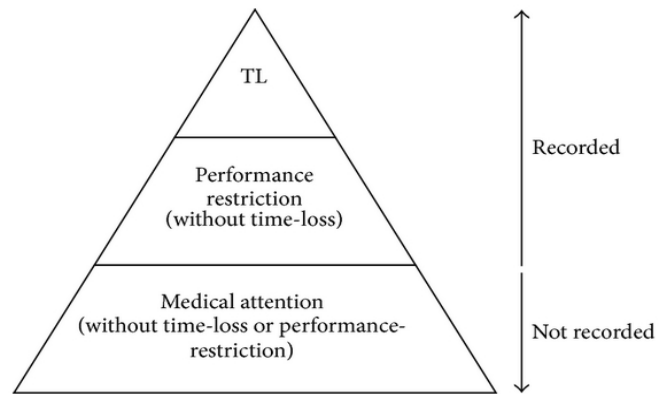
$$g_M^G(y) = M_y^G(y) - \sum_i M_i^G(y) \tag{11}$$

Through the inductive language, the practitioner can mobilize his limbs to move under the guidance of the idea. Establishment of muscle impact model under exercise training:

$$g_D(y) = \frac{L}{350} - \sum_i D_i(y, A) \tag{12}$$

When the body is fatigued, the reaction time is prolonged and the number of errors increases. Psychological fatigue has a greater impact on the reaction, while simple muscle fatigue has less effect on

the reaction. The use of music stimulation training has a positive effect on the elimination of athletes' mental fatigue and a greater use value. The relaxation and relaxation training of the athletes through the electrical stimulation of the muscle function can relax the muscles of the athletes as shown in the classification of the injuries in the training (Figure 6).



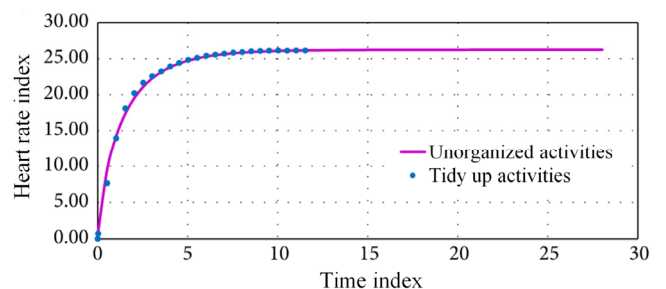
**Figure 6.** Classification of damage definition in training

Through the investigation of the time of sports injuries of athletes. The injury of athletes is mainly caused by sports training, and the incidence rate during training is 78%. The incidence of injury during the game was 18%. Injury caused by other reasons accounted for 6%. Therefore, the prevention and treatment of sports injuries is mainly during exercise training, as shown in Table 5.

**Table 5.** Basketball player sports injury type data

Injury stage	Number of injured persons	Proportion (%)
Train	156	78
Match	36	18
Amateur	12	6

Subjects listened to fast-paced rock music during their exercise, and the impact of pop music on reducing physical fatigue caused by exercise was significantly greater than that of fast-paced folk music. At the same time, the overall sports fatigue of the body also often contains the local sports fatigue of a certain muscle group. Figure 7 shows whether music stimulation affects heart rate comparison in the training session.



**Figure 7.** Comparison of heart rate in the case of music stimulation

By the end of the exercise, the subjects in each group had reached the state of conscious fatigue. Compared with pre-exercise, post-exercise response time is shorter. This is inconsistent with the diagnosis of fatigue, which may be due to the consistency of the parameters selected before and after exercise. Participants 'motivation and active involvement in low intensity exercise were significantly higher than those in high intensity exercise, and the physiological fatigue caused by low intensity exercise was significantly lower than that caused by high intensity exercise [25]. The factors related to reading are investigated which distress visual fatigue [26]. Learning based on self-regulation is presented to facilitate and collaborate the students learning easier [27]. It shows that listening to fast-paced rock music and pop music during exercise has a more significant positive effect on reducing physical fatigue of subjects. Psychosomatic means mind and body, it prone particularly to made inferior by cerebral factors for example anxiety and stress. The results of the psychosomatic calm subscale showed that there was no significant difference in the sense of peace and relaxation between the subjects in both high-intensity and low-intensity exercises. Subjects who have been listening to music since the beginning of the exercise have the longest duration of exercise. It shows that listening to music can improve strength and endurance, but its effect time is relatively short, and it is better to listen to music from beginning to end. After the exercise, the number of errors in the response of each group of subjects was significantly increased, indicating that the subject's nervous system had fatigued at the end of the aerobic treadmill exercise.

## 5 Conclusions

In lower-intensity exercise, listening to fast-paced rock music and pop music is better for reducing the physical fatigue of low-cardiac endurance students than fast-paced folk music. Subjects had a lower degree of lactic acid accumulation during exercise and a shorter body recovery time after exercise, which had a good physical and mental adjustment. Listening to the music of choice and fast-paced music during the exercise all delays the physical and mental fatigue, improves the aerobic exercise ability, and has its own characteristics, which is worth promoting. Slow-paced music has no such effect and is not recommended for use in sports. Strengthening music research to improve the sports interest and exercise habits of people with low cardiopulmonary endurance is a very practical topic. In aerobic treadmill exercise, slow rhythm music auditory stimulation has no obvious positive effect on prolonging exercise time, alleviating exercise-induced fatigue of skeletal muscle, cardiovascular and nervous system, and improving bad mood in exercise. In the future, while listening to music in sports, we can explore suitable exercise time for college students with

low cardiopulmonary endurance. Further explore the sports music prescription suitable for low cardiopulmonary endurance College students, make them more active in physical exercise, and then achieve better exercise effect. It will provide a more complete theoretical basis for future scientific research work and lay a solid foundation for the formulation of scientific sports music prescriptions.

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