Mechanical properties of basin loess based on image recognition and aerobic exercise data monitoring of athletes

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Received: 5 June 2021 / Accepted: 15 July 2021 / Published online: 13 August 2021
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Abstract
Image recognition technology is an important part of machine vision applications. In the process of image recognition, the perception mechanism must exclude the input redundant information and extract important information. Loess is rich in calcium carbonate, and its particles are mainly composed of silt soil with obvious pores between soil particles. Loess in the basin is characterized by high water content, easy collapse, strong permeability, and easy collapse. Loess is very vulnerable to the influence of water, which greatly reduces the support of loess. Most of the quality problems of loess foundation-related projects in the basin are caused by insufficient support. In this paper, the loess in the watershed is selected as the investigation object. Firstly, in order to investigate the change of mechanical properties of loess, freezing thawing cycle, alternation of drying and wetting, and non-direct shear and compaction tests were carried out under these combined effects. Then, combined with the numerical simulation software geo-studio, the effects of temperature field, infiltration field, freezing and melting cycle, and wetting and drying alternation on the slope stability were simulated. Aerobic exercise is helpful to maintain the physiological health of the subjects; the results show that aerobic exercise with small intensity, moderate intensity, and medium intensity has a positive effect on the inhibition and conversion function of athletes’ brain; aerobic exercise of three intensities can promote the development of brain refresh function; the results show that aerobic exercise of small plus medium intensity and small plus intensity has a positive effect on the brain switch and inhibition function when athletes complete cognitive tasks. Based on the image recognition technology, this paper discusses the mechanical properties of loess in the basin and studies the monitoring of aerobic exercise data of athletes.

Keywords Image recognition; Basin; Mechanical properties of loess; Athletes; Aerobic exercise

Introduction
According to the detection method of image analysis, it is mainly based on the infrared image which can reflect the temperature distribution of solar cells in different working states. The image recognition is realized through machine learning and image processing (Mirza et al. 2007). This method is not only more efficient than the detection method based on electrical characteristics monitoring, but also does not need to build the surrounding physical circuit. This is a non-contact hot spot detection method, which will not affect the image recognition components. Infrared image mainly reflects the difference of temperature distribution between foreground and background. The more obvious the temperature difference is, the higher the definition of the image is. The temperature difference in the foreground is generally small, and the temperature difference between the actual scene points and the background is complex (Basir et al. 2013). The temperature in the background area may be higher than that in the foreground area. In other words, it’s more like the background area of infrared radiation than the foreground. In this paper, the unsaturated loess in the basin is taken as the research object (Castillo et al. 2016). Under the action of freezing thawing cycle and dry wet alternation, the variation characteristics of soil shear strength parameters, compression and compression functions are defined, and the finite element analysis software is used to establish the freezing thawing and dry wet model of
the inclined plane, and the change characteristics of temperature field and seepage field are measured. Finally, the evolution rule of various slope safety rates is investigated. The main research contents are as follows: through direct shear test, the influence of moisture content, drying density and shear strength parameters cycle is tested, the freezing and thawing cycles are studied, the strength parameters and internal dynamic mechanism under the effect of dry wet alternation and shear change rules are studied, and the fitting function between shear strength parameters and moisture content, drying density and cycle is established. The relationship between compaction test and freeze-thaw is obtained under the compression characteristic curve of the sample. The characteristics of moisture content, drying density, cycle time, and compression relationship of loess are analyzed (Mahatta et al. 2014). The change rules of freeze-thaw cycle under the dry wet alternation and comprehensive compression function and the evolution rules under the change mechanism are clarified (Adnan et al. 2012). By using the finite element analysis software, the changes of temperature field and seepage field of slope under different climatic conditions were simulated, and the evolution law of slope safety rate of various slopes was investigated. According to the research, aerobic exercise can effectively promote the healthy development of athletes (Manzoor et al. 2015). In a study conducted by dietricha et al., athletes were intervened by the combination of treadmill and power bicycle for 6 months. The results showed that aerobic exercise increased the flexibility of executive function, and improved the ability of continuous attention and working memory. One month after stopping the intervention, the follow-up study found that executive function returned to the level before intervention. Moreover, in the field of sports psychology, the research on the positive effect of aerobic exercise (AE) on executive function is more and more clear. It is suggested that AE can be used as a means to improve and strengthen executive function. On this basis, through detailed investigation, it is found that acute aerobic exercise can also improve the executive function of athletes. This has become a hot topic in the field of sports cognitive science (Aras et al. 2004).

Material and methods

Sample preparation

Prepare the soil sample, take the soil under the ground, screen the soil through a 0.5-mm diameter mesh plate, and then mix the soil evenly, measure the water content, and calculate the amount of water to be added to the specific sample according to Eq. (1). Through watering, the soil surface is watered evenly to make the water distribution more uniform. Put the mixed soil sample into the moisture tank for use. Take out the excavated samples and calculate the mass of samples with various dry densities according to Eqs. (2) and (3). The calculation method is different for different dry density of laminted samples. The sample was pressed to three layers, and the contact surface between the layers was cleaned, which ensured the sealing of the contact between the soil layers and the integrity of the sample in the preparation process. In order to avoid the influence of various sample errors on the test results, the drying density error of the sample must be controlled within 0.02g/cm3. Finally, put the prepared sample into the moisturizer for 24 h to keep the moisture uniform. The moisture content of the sample needs to be tested again before use. The difference between the measured moisture content and the necessary moisture content shall not exceed 1%. Otherwise, the moisture content of the sample needs to be adjusted before it is identified.

\[
m_w = \frac{0.01 \times (w - w_0)}{1 + 0.01w_0} \times m
\]

(1)

\[
\rho = \rho_d(1 + w)
\]

(2)

\[
\rho = \frac{m}{V}
\]

(3)

According to the test conditions, samples with different moisture content should be prepared. According to formula (1), a certain amount of reconstituted clay is taken out and the composition of the sample is calculated. Secondly, sprinkle water on the soil surface by spraying, so that the moisture distribution is uniform. However, this process requires manual stirring, which is fully stirred in accordance with the preparation method of the reconstituted soil sample, and can only be used after standing for 24 h in the moisturizing tank. After standing, take out the sample and test the moisture content of the sample again. The difference between the measured moisture content and the necessary moisture content shall not exceed 1%. Otherwise, the moisture content of the sample needs to be adjusted. For specific operation, please refer to the operation method in the previous section.

Experimental equipment and methods

Due to the large fluctuation range of drying density and moisture content of the sample, the sample is easy to produce cracks in freeze-thaw and dry wet cycle, so the sample cannot be made according to the required size. In order to obtain more uniform and accurate results, the shear strength parameters of samples before and after freeze-thaw and wetting were compared and studied by direct shear apparatus (Cebecauer and Suri 2016).

The experimental device is an electrical quadruple plane shear device of the Foundation Engineering Research Institute of the University. It has the advantages of simple structure, convenient operation, and stable performance. The
instrument is driven by a low speed synchronous motor. In the test, the vibration is small and the shear velocity is stable. In the shearing process, the vertical pressure of 100KPa, 200KPa, 300KPa, and 400KPa is continuously added to the sample and sheared at the speed of 0.8mm/min, so the sample is damaged in 3–5 min. After reaching the shear strength of the specimen, the weak part of the specimen will produce plastic flow until the shear failure, which eventually leads to the slip of the specimen, that is, the overall failure.

Image recognition algorithm processing

The collected images usually have different degrees of tilt and zoom. If these images are processed directly, the calculated features will inevitably make mistakes, which will easily lead to recognition errors. Therefore, in this section, the image is standardized, that is, the image is positioned to meet the standard size and shape set for the image. The main steps are image tilt correction and image scaling.

Cubic convolution interpolation algorithm is an improved version of quadratic interpolation, which is a more complex interpolation algorithm (Georgiou and Skarlatos 2016). The algorithm has the highest zoom effect on the image and retains a lot of information of the original image. On the other hand, the image can generate smoother edges than one-time interpolation, but the cost is the highest and the most complex. In a word, when choosing the interpolation algorithm, the interpolation algorithm or cubic convolution interpolation algorithm is used in the region with high image quality, and the nearest neighbor interpolation algorithm is used in the region with low image quality.

In order to reduce or eliminate Gaussian noise, we need to introduce Gaussian filter in the process of image processing. This filtering algorithm can effectively reduce the noise. In this chapter, the core number is 5 × 5, as shown in Eqs. (4) and (5).

\[
F(x, y) = f(x, y) \ast G(x, y)
\]

(4)

\[
G(x, y) = \frac{1}{\sqrt{\pi}} e^{-\frac{x^2}{\sigma^2}}
\]

(5)

Rotational symmetry is a significant feature of two-dimensional Gaussian function. After the image is processed by the algorithm in this section, it can not only meet the needs of noise reduction, but also fully retain the rich edge details.

Create an M × N two dimensional matrix im × N. The dimensions of M and N are the same as the original image, and the local standard deviation is calculated. In the image processing of this section, the current pixel is located in the center of the sliding window, so the size of the image processing window is generally odd, and the size of the sliding window is also related to the operation speed. The larger the selection window is, the more time is spent to complete the calculation. Based on the above reasons and practical experience, this section selects 5 algorithms × 5 sliding window (Lee et al. 2009). Through the average value calculation formula (5) and standard deviation calculation formula (6), the local standard deviation calculation formula in the current window is as follows:

\[
\bar{a}(i, j) = \frac{1}{K^2} \sum_{i=1}^{K} \sum_{j=1}^{K} a(s, t)
\]

(6)

\[
G(i, j) = \sqrt{\frac{1}{K^2} \sum_{i=1}^{K} \sum_{j=1}^{K} \left[ a(s, t) - \bar{a}(i, j) \right]}
\]

(7)

The threshold T is set by threshold function threshold, and the two-dimensional matrix is binarized by formula (8), and the corresponding binarization image is output. The threshold T used in this section is the local standard deviation matrix im × The mean value of the elements of n is calculated by formula (9). The threshold conditions are as follows:

\[
\delta_i = \frac{1}{\| \omega \|} \| G(x) \|
\]

(8)

\[
T = \frac{1}{40 \times 480} \sum_{i=1}^{640} \sum_{j=1}^{480} I(m, n)
\]

(9)

Athletes aerobic exercise data monitoring methods

In this study, each athlete has to receive three times of aerobic exercise intervention to determine the best way of exercise for the crowd. As shown in Fig. 1:

Finally, a total of 10 athletes met the inclusion criteria. Before and after the exercise intervention, physiological indicators, behavioral task indicators and EEG indicators of each athlete were tested and data collected. The physiological indexes of 10 athletes were collected by Masimo radical-7 finger clip pulse oximeter made in the United States. The biggest advantage of the device is the timeliness of parameter display, noninvasive to human body, and continuous monitoring in vivo. Based on this, the effects of aerobic exercise with different intensity combinations on Physiological Indexes of college students are analyzed. The 64 channel EEG recorder produced by neuroscan company of the US is used to collect the athletes’ EEG indexes. The EEG recorder has the most advanced synamps2 electrophysiological amplifier in the world. The good online real-time spectrum analysis function of the software can improve the high fidelity of the data collected in the experiment and make the data analysis structure more accurate and reliable.
Results

Analysis of shear strength and its influencing factors of loess in the basin

Using the experimental data, the relationship curve between shear stress and shear displacement is drawn, and the peak point or stable value of the curve (shear stress with shear displacement equal to 4mm) is taken as the shear strength. Then, the vertical axis represents the shear strength and the abscissa represents the vertical stress. The relationship curve between shear strength and vertical stress is drawn and fitted. The correlation coefficients of all linear fitting are more than 0.99. The test results are shown in Table 1.

It can be seen from Fig. 2 that under the same drying density and moisture content, with the increase of clay content, the cohesion increases as a whole. When the clay content is lower than 20%, the overall change trend is slow, and the average growth rate of each stage is 6.5%. This is because the clay content in this stage is generally very small, most of which exist in the pores and contact points between the silt particles. The cohesive force is mainly due to the interaction of the powder particles and the surrounding clay particles. If the clay content exceeds 20%, the overall tendency will increase rapidly, and the average growth rate will reach 15%. This shows that, at this stage, the growth of clay content is basically the inclusion of clay powder particles, and the shear failure process is affected. The cohesion is mainly caused by the agglutination between clay and clay. The greater the cementation, the higher the cohesion.

Under the same clay content, the effect of moisture content on cohesion c does not change monotonously. In order to more directly analyze the influence of water content on cohesion under various clay content conditions, the curves of cohesion and water content change are depicted as shown in Fig. 3.

| Strength parameters | Clay content of sample |
|---------------------|-----------------------|
|                     | 12%  | 16%  | 20%  | 24%  |
| c/kPa               | 45.80| 48.08| 52.68| 62.99|
| \(\phi^o\)          | 29.98| 26.16| 25.03| 25.72|
| c/kPa               | 70.43| 72.12| 76.13| 85.86|
| \(\phi^o\)          | 27.71| 24.38| 22.45| 23.01|
| c/kPa               | 34.34| 36.92| 40.64| 45.30|
| \(\phi^o\)          | 26.75| 23.90| 21.54| 21.87|
| c/kPa               | 26.90| 28.61| 30.68| 35.85|
| \(\phi^o\)          | 25.13| 22.38| 19.57| 20.07|
Now, it is generally believed that the tensile strength of agglutinative materials mainly comes from the cohesion of materials. In order to analyze the composition of cohesive force of loess from the perspective of the most basic unit particle of loess material, the generation of cohesive force can be approximated to the following three cases, and its micro mechanism can be analyzed. In the first case, under the action of tensile stress, the separation of relatively weak clay destroys the geometric surface on both sides of cohesive force, and the minimum tensile process stress required for this process can be expressed as the sum of cohesive force (Fig. 4a). In the second case, the coating is carried out under the action of tensile stress to form the powder particles of the surrounding clay. In this process, the relatively weak clay and powder particles destroy the geometric surfaces on both sides of the cohesive force. The minimum tensile stress required may represent the cohesive unit contributed by the component (Fig. 4b). The third case is the irregular shape or structure of the internal structural stress of the particle. Under the influence of tensile stress, the tensile stress is the cohesive force of the component at a specific angle (Fig. 4c).

In order to study the internal friction angle of clay with different moisture content $\phi$. As shown in Fig. 5, the variation curves of cohesion and clay content are depicted. At the same moisture content, when the clay content is less than 20%, the internal friction angle will decrease with the increase of clay content. The reason for this phenomenon is that the friction at this stage is mainly caused by the interaction between particles. With the increase of clay particles, part of the clay particles begins to gather towards the contact points between particles. As a result, the lubrication effect of the relatively stable frame structure between particles is retained. The embedding effect will gradually decrease, and the corresponding friction will decrease. When the clay content continues to increase, the clay particles completely separate the powder particles, and the friction begins to be caused by the interaction between clay particles. Therefore, when the clay content exceeds 20%, the internal friction angle begins to increase slowly with the increase of clay content.

Consolidation characteristics and influencing factors of loess in Basin

In order to analyze and compare the non-structural differences of different clay contents, as shown in Fig. 6, according to the data obtained from the test, the compression curves of unchanged samples and re-formed samples with different clay contents were obtained.

With the increase of water content, the softening effect of water on the structure of the reformed sample is gradually enhanced, the compression curve is gradually steeper, and the amount of compression is also increased. Figure 7 shows the relationship between compression pressure and compression deformation under different clay content. The samples with different clay content can be seen that there is a positive correlation between water content and compression. Through the analysis of the difference between the two, in the compaction test, with the increase of moisture content, the phenomenon of compression deformation increases is that the test load time needs to be increased by 24 h for each level, the recovery of the soil sample with secondary compaction is destroyed within the load, and the resistance of the external load of the sample is supported by the friction between particles, The interaction dominated by friction decreases gradually with the increase of water content, and the compression deformation can be more fully exerted. Therefore, compression tends to increase gradually.

Under the working condition of 14% water content, the time strain ratio ($t/\varepsilon$) of each load stage is used to analyze...
the relationship between load time and load time. The $t/\varepsilon-t$ curve under various compressive stresses is shown in Fig. 8.

The $t/\varepsilon-t$ curve of each loading stage shows the same rule.

In this chapter, taking the linear relationship of $t/\varepsilon-t$ of 800kpa as an example, the relationship between the linear regression equation of various clay contents and the gradient B is obtained. As shown in Fig. 9:

![Fig. 4 Shear diagram of different failure units](image)

**Dynamic characteristics and influencing factors of loess in the basin**

According to the test data points, as shown in Fig. 10, the relationship curves between dynamic shear modulus and dynamic shear strain of remolded loess samples with different clay contents under different confining pressures are depicted. With the increase of dynamic shear strain, the dynamic shear elastic modulus of loess samples with different clay content will gradually decrease, resulting in rigid softening.

In addition, it can be seen that the dynamic shear elastic modulus and dynamic shear strain curve of loess samples with different clay content show the same development mode, showing good hyperboloid characteristics. The dynamic stress of soil—the hyperboloid model used to explain the strain relationship is shown in Fig. 11.

According to the test data points, as shown in Fig. 12, the relationship between damping ratio and dynamic shear strain of remolded loess samples with different clay content under different sealing pressures is described. With the increase of dynamic shear strain, the damping ratio with different clay content will gradually increase. When the deviation is small, the variation range of damping ratio is small, and when the dynamic shear strain is large, the
growth rate of damping ratio is obviously fast and tends to be stable. Under the same conditions, the influence of clay content on shear strain and damping ratio also shows a non-monotonic change. With the increase of clay content, the damping ratio of loess samples begins to increase, and then presents a trend of change. When the clay content reaches 20%, the shear strain becomes more obvious. The results show that when the clay content continues to increase, the influence of loess sample on dynamic load response lag will first increase, and then gradually decrease.

Please refer to Fig. 13. Damping ratio is an important index to reflect the response of soil to dynamic load, $\lambda_{\text{Max}}$ is the main parameter to establish the equivalent dynamic viscoelastic constitutive model. The variation rule of $\lambda_{\text{Max}}$ is very useful for analyzing the differences between the parameters of the same dynamic viscoelastic constitutive model of loess samples with different clay contents.

According to the experience of seed and Idris, the initial (maximum) dynamic modulus and effective consolidation pressure can be regressed and fitted, as shown in Fig. 14.

The influence mechanism of clay on dynamic shear modulus and damping ratio of loess can be analyzed from the microscopic characteristics of loess samples with different clay content. According to the mechanism of clay particles, the content of clay can be divided into two stages when observing the microstructure of samples. In order to analyze the microstructure of samples more intuitively, a conceptual model of binary structure of loess samples with different clay contents is established, as shown in Fig. 15.

**Analysis of monitoring results of aerobic exercise data of athletes**

Before the experiment, the physiological and biochemical indexes of the two groups were tested for homogeneity, and the results...
are shown in Table 2. It can be seen from the statistical results that there is no difference in heart rate \( P = 0.29 \), blood oxygen saturation \( P = 0.10 \), and blood perfusion index \( P = 0.73 \) between the two groups, which indicates that the relevant physiological indexes of the two groups of athletes are homogeneous before the experiment.

The data of oxygen saturation of athletes before and after exercise were analyzed by paired sample t-test, in order to discuss the changes of oxygen saturation before and after each intensity of exercise. The results show that the results of intensity 1, intensity 2 and intensity 3 before and after exercise are respectively \( t = 1.395, P = 0.196 \), \( t = 0.758, P = 0.47 > 0.05 \), \( t = 0.452, P = 0.66 \) (Table 3). The statistical results show that the indexes of blood oxygen saturation of athletes before and after exercise with different intensities have no significant changes.

In order to discuss the change of blood flow perfusion index before and after each intensity exercise, paired sample t test was used to analyze the blood flow perfusion index of athletes before and after exercise. The results showed that the comparison results of intensity 1, intensity 2 and intensity 3 before and after exercise were \( t = -0.704, P = 0.499 \), \( t = -1.225, P = 0.252 \), \( t = -0.97, P = 0.357 \) (Table 4), respectively. It can be seen that there was no significant change in the blood perfusion index of athletes before and after exercise with different intensities.

**Discussion**

**Analysis of the effects of aerobic exercise with different intensity combinations on physiological indexes of athletes**

**Test results analysis of heart rate and conscious fatigue**

Both RPE and HR are simple physiological indexes to describe exercise intensity. In this experiment, the maximum value of heart rate and RPE of athletes appeared immediately after exercise. Furthermore, aerobic exercise of different intensity combinations caused a certain degree of fatigue stimulation to the heart rate and self-feeling of college students. Before and after moderate intensity exercise, the heart rate of athletes reached 152.70 ± 21, while RPE reached 14.
Through the overall analysis and comparison of the two indicators, it is found that there is a linear relationship between the change of heart rate and the change of RPE value after exercise. Specifically, aerobic exercise of small plus medium intensity, small plus intensity and medium plus intensity is an increasing load exercise for athletes. In the fatigue evaluation of acute aerobic exercise, the combination of physiological indexes such as blood perfusion index, blood oxygen saturation, RPE, and heart rate into the actual evaluation of exercise fatigue may more objectively, accurately and comprehensively reflect the benefits of exercise intensity, exercise time, and muscle working state in different regions (Pohekar and Ramachandran 2004).

Analysis of blood oxygen saturation test results

Blood oxygen saturation (SO2) refers to the percentage of total oxygen bound hemoglobin in the blood, which is the basic parameter of human skeletal muscle physiology. It is related to blood flow regulation and oxidative energy...
metabolism, and affects the release of ATP in red blood cells and the regulation of ATP concentration in blood vessels (Ramachandra et al. 2011). In this experiment, the data of blood oxygen saturation of athletes before and after exercise were collected by finger clip method. The results show that the blood oxygen saturation of college athletes after three kinds of aerobic exercise is not significantly affected. The reason for
this phenomenon may be that the exercise intensity involved in this experiment is not deep enough for athletes. Therefore, it is the direct reason that all kinds of aerobic exercise modes do not lead to the change of body oxygen supply level.

Analysis of blood perfusion index test results

The perfusion index (PI) is derived from the photoelectric plethysmography signal of pulse oximeter. It is calculated by the ratio of pulse component (artery) and non-pulse component (venous blood, connective tissue, etc.) that can be detected by the detector. In quiet state and exercise, blood perfusion can regulate skeletal muscle oxygen and nutrient supply through blood, and can reflect blood circulation or metabolism. It is a key index to evaluate the function of microcirculation system (Riaz et al. 2014). However, as we know, blood perfusion is uneven, and different measurement sites will directly lead to the difference of blood perfusion index. This difference is not only reflected in the tissues, but also reflected in the skeletal muscle and between skeletal muscles. In this experiment, the data collection of athletes’ blood flow perfusion index is carried out by finger clip method, and the statistical analysis of relevant physiological indexes shows that the athletes’ blood flow perfusion index does not change significantly after three different intensities of aerobic exercise. The potential factors causing this phenomenon may be related to the way of exercise. In this experiment, the aerobic exercise intervention mode applied to the athletes was completed on the running platform, and the athletes’ working muscles were more concentrated in the lower limbs. In contrast, the working

Fig. 12 Relationship curve under different clay content

Fig. 13 Large damping ratio $\lambda_{\text{max}}$, Relationship curve between soil moisture and clay content
range or time of the upper limbs was very limited. Some studies pointed out that different muscle tissues had different perfusion levels during exercise (Stokler et al. 2016). Therefore, the mismatch between the finger clip method and the muscle working area may be the cause of the experimental results.

Analysis of POMs emotional scale test results

The POMS emotional scale used in this study includes 40 emotional adjectives, a total of seven. The investigation from the emotional dimension can evaluate the self-feeling of athletes at present and in the past week. Generally speaking, after aerobic exercise of three intensities, the emotion change rules of seven dimensions of athletes are not the same. Specifically, although aerobic exercise of intensity 2 also has a certain effect on the development of different emotions, the statistical analysis shows that the exercise mode of intensity 2 has no statistically significant effect on the emotion of different dimensions of athletes (Zell et al. 2008). In intensity 1 aerobic exercise, the tension of athletes has been significantly improved after the exercise, and in intensity 3 aerobic exercise, the self-esteem of athletes has been

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![Fig. 14](image1.png) Fitting curve of relationship between initial modulus and effective consolidation pressure

![Fig. 15](image2.png) Conceptual model of binary microstructure of loess with different clay content

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significantly improved after the exercise. Therefore, it is considered that the significant impact of a single 30-min aerobic exercise with small intensity plus medium intensity and medium intensity plus high intensity on the emotions of athletes is less significant than that of aerobic exercise with small intensity plus high intensity under the same conditions. It has a better role in promoting the improvement of college athletes’ emotion.

**Analysis of test results of general emotional disorder**

Emotion is an indispensable part of our daily life. It is like a barometer, which can reflect our general mental health state, change human general behavior pattern and affect our physical and mental health. Some studies have pointed out that there is a two-way relationship between mood state and physical health to some extent. What kind of effect does acute aerobic exercise of different intensity bring to human body? In this experiment, the TMD index after moderate and moderate intensity exercise is lower than that before exercise, which is a positive signal for human emotions. The results are consistent with previous research results. For example, Sibold et al. explored the effect of moderate intensity aerobic exercise on mood state of college athletes. Thirteen male athletes and 35 female athletes aged 18–25 were randomly divided into exercise group and quiet group. The exercise group was asked to pedal for 20 min with 60% VO2max. The changes of mood disorder index were recorded before exercise, immediately after exercise, 1, 2 h, 4 h, 7 h, 12 h, and 24 h after exercise. Besides being told to make efforts to adjust work and rest, the athletes also reported their mood state accurately at the appointed time. The error value should not exceed ±15 min. The results show that the emotional disorder index of the athletes in the exercise group is lower than that in the quiet group immediately after the exercise, 4 h, 8 h, and 12 h after the exercise, and there is no gender main effect, which indicates that moderate intensity aerobic exercise can continuously bring positive effects to the human body after the exercise or even for a period of time after the exercise. Different intensity of aerobic exercise optimizes the psychological state of college athletes. It has been reported that there may be two reasons for the phenomenon of emotional optimization after exercise. Firstly, the content of monoamines is increased, especially the hormone level represented by norepinephrine and 5-hydroxytryptamine; The second is the release of endorphin hormone. In addition, the results of this study are consistent with the view that aerobic exercise can be used as an effective means to improve the mental health of college students. From the aspect of physiology, aerobic exercise of small plus medium intensity and medium plus intensity can improve the mood of athletes, and the heart rate and fatigue index have significant changes compared with those before exercise, while other physiological indexes have no significant changes; the results show that the heart rate and fatigue index of college students are significantly changed by aerobic exercise, but it cannot bring significant changes to the mood of the subjects. In addition, the changes of other physiological indexes after exercise were not significant.

**Table 2** Homogeneity test of physiological indexes of athletes before experiment

| Heart rate (BPM) | Blood oxygen saturation (%) | Blood perfusion index (%) |
|------------------|-----------------------------|--------------------------|
| F    | P    | F     | P    | F | P |
| 0.003 | 0.29 | 0.23  | 0.10 | 0.70 | 0.73 |

**Table 3** The influence of aerobic exercise with different intensity combination on Athletes’ blood oxygen saturation

| Exercise intensity | Before exercise | After exercise |
|--------------------|-----------------|----------------|
| Intensity 1        | 97.10±2.13      | 96.30±1.77     |
| Intensity 2        | 97.00±1.94      | 96.70±1.25     |
| Intensity 3        | 97.60±1.17      | 97.40±0.97     |

**Table 4** Effect of aerobic exercise with different intensity combination on Athletes’ blood perfusion index

| Exercise intensity | Before exercise | After exercise |
|--------------------|-----------------|----------------|
| Intensity 1        | 5.72±5.03       | 7.45±6.91      |
| Intensity 2        | 5.57±3.32       | 6.68±2.09      |
| Intensity 3        | 5.71±4.40       | 7.70±5.28      |
to improve the level of cerebral blood flow and oxygen perfusion, and then can improve the cognitive performance of the human body. In this study, we used the classic Erickson improved arrow flanker task to evaluate the effect of athletes on brain inhibition function before and after different intensity of exercise, and compared and analyzed the two indicators of reaction time and accuracy of athletes when performing the flanker task. The results show that acute aerobic exercise can improve the cognitive level of athletes, which is consistent with the previous research results.

After analyzing the behavioral data of athletes before and after exercise, it is found that the test time of reaction time in the flanker consistency task is shorter. The intensity interaction effect \( P = 0.018 < 0.05 \) was significant. Further analysis found that after moderate and high intensity exercise, the improvement effect on Athletes’ reaction time was the most significant, indicating that acute moderate and high intensity aerobic exercise is more beneficial to the improvement of athletes’ brain inhibition function, which is consistent with the previous research results on behavior. For example, Westfall and his research team conducted a comparative analysis of the effects of 9 minutes of high-intensity intermittent exercise and 20 min of continuous moderate and high-intensity aerobic exercise on athletes. The results showed that after 20 min of continuous moderate and high-intensity exercise, the reaction time of the consistent task of flanker was significantly shorter than that before exercise, which indicated that after acute moderate and high-intensity exercise, the reaction time of the consistent task of flanker was significantly shorter than that before exercise. It can improve the inhibitory function of the brain. The ability to solve simple conflict problems benefits the most. Brown et al. Randomly assigned 85 athletes to high-intensity intermittent exercise group, high-intensity aerobic exercise group, moderate intensity aerobic exercise group and low-intensity exercise group. The exercise time of each group was 38 min. Immediately after exercise, 10 min after exercise and 30 min after exercise, the athletes completed stop signal task and Stroop task respectively. The Stroop task response time of high-intensity aerobic exercise group and low-intensity aerobic exercise group still showed a more significant improvement effect, indicating that acute aerobic exercise has a positive effect on the improvement of athletes’ cognitive function, and the positive effect still exists 30 min after exercise.

Analysis of the influence of sports intervention on athletes’ brain refresh function

Refresh function is another branch of executive function of brain, which reflects the executive system of brain. This system stores, maintains and updates complex action related information in a short time, which is the basis of human thinking process. In this study, we used the 2-back task of n-back task to investigate the changes of athletes’ refresh function under complex task conditions after aerobic exercise of different intensities. We also investigated the P300 latency and P300 amplitude of event-related potential, which reflected the activation degree of athletes’ brain, so as to know the positive benefits of aerobic exercise of different intensities for the group. The behavioral data in this study showed that the response time of 2-back task was shorter than that of the control. The interaction of intensity showed a significant difference \( P = 0.022 < 0.05 \). Through the comparison of the analysis results, it can be seen that the difference of reaction time of athletes in this task state is more significant before and after small plus medium intensity exercise, which is consistent with the previous research conclusion. For example, gothe et al. Conducted a study on 21 athletes to investigate the change rule of athletes’ refresh function through different ways of aerobic exercise. Specifically, the intervention form of aerobic exercise is divided into 30 min of yoga training and 30 min of treadmill exercise (heart rate is 60–70% of the maximum heart rate). The 2-back reaction time and accuracy of the two groups were improved compared with the baseline level, especially in the yoga group, which showed that different forms of aerobic exercise have different promotion effects on the refresh function of the group, but had a positive impact on the human body as a whole.

The interaction between aerobic exercise and physical, psychological and brain activation of athletes

The physical and mental health of athletes is the primary premise for the country to cultivate reserve talents. Executive function plays a vital role in the healthy development of athletes' physiology and psychology, and provides an important basic guarantee for the group's life, learning and other aspects. Therefore, it is of great significance to maintain and further develop athletes' physiological and psychological level. Studies have shown that aerobic exercise is an effective means to promote the physical and mental health of athletes. The results of this study show that aerobic exercise can promote the development of physiological function of athletes, but also has a positive effect on their executive function. This is consistent with the results of previous studies.

Specifically, only under the aerobic exercise load of small plus medium intensity and medium plus intensity, the mood state of athletes can be improved, and under the three aerobic exercise modes, the blood transportation oxygen capacity and perfusion level of athletes can be maintained; the results show that the three aerobic exercise modes can improve the refresh function of the brain, and the inhibition function and conversion function of the athletes' brain are also improved under the small plus medium intensity and medium plus intensity exercise modes. The brain activation level of conversion and
inhibition function has also changed significantly. Therefore, the ways and principles of aerobic exercise on the physical and mental effects of athletes need to be further explored.

**Conclusion**

According to the theory and research methods of ecological risk assessment, a theoretical framework for land ecological risk analysis and assessment is established. Based on the characteristics and risk analysis of urban water and soil resource loss, this article discusses soil and water conservation management measures and the content of management measures in urban construction. Based on the urban development plan and the status of soil and water protection, protection measures are implemented according to the regional conditions. The quadratic structural equation model affects the economic mechanism of public services based on digital technology. The application of digital technology and the efficiency of public services play an important role in digitization, network, intelligent society, and more and more public service processes, and are directly related. The form of high-level alliance provided across borders between the government, enterprises, society, and citizens has even formed an independent choice in the public service market.

**Declarations**

**Conflict of interest**  The authors declare that they have no competing interests.

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