Ocean surface circulation based on video features and swimmer training monitoring

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Abstract
This paper aims at efficient recognition and video features and then studies the ocean surface circulation movement, and then a fusion method based on video dynamic and static features is designed for swimmer training monitoring. Finally, a video feature classification method based on dual stream improved C3d is designed to complete the recognition and classification. Then the characteristics of seasonal variation of tropical ocean surface circulation are analyzed, and the possible mode of seasonal water exchange between bay and ocean is discussed. Next, we analyze the temperature and salinity structure of the upper part of the ocean, the spatial distribution of the Arabian Sea and the Gulf, and the characteristics of seasonal variation. The expansion path and scope of the two water masses in the study area are clarified. Finally, the Bay Estuary 6° N segment, the net salt flux, and freshwater transport formula are used to quantitatively analyze the water exchange process of the tropical ocean surface circulation. Next, we will analyze the blood lactic acid level of the best Chinese swimmers, and note that Chinese swimmers are slightly insufficient in the case of high-intensity exercise. The lactic acid in the blood of the competition will be affected by the way of swimming, the gender of the athletes, and the venue of the competition. The purpose of training monitoring is to timely understand the athletes’ body reaction to sports training, prevent excessive fatigue and sports injury, maximize sports performance in a short period of time, and achieve good results in the next ten games swimming competition. Based on the research of ocean surface circulation and swimmer training monitoring, this paper applies it to the video features, so as to improve the performance of swimmers.

Keywords Video features · Ocean surface circulation · Swimmers · Training monitoring

Introduction
According to the characteristic of video, this paper proposes a new sequential action localization algorithm and designs a multistream sequential network (MTN) and proposed scoring network (PSN). The multimodal information such as image, audio, action, and so on is used to encode the video feature content as the input of the network to enrich the feature coding information. In order to make the best use of a modal feature which is more advantageous to locate the real target action, the early fusion method is used for timing operation of different modal features (Modarres et al. 2016). The middle layer feature fusion branches of different modes and the temporal convolution layer are added to extract the proposed level features of the video so that the multimodal information can be deeply fused and the key content of the video can be highly represented (Najafi et al. 2013). The active vertical ocean surface circulation plays an important role in ocean dynamics and thermodynamics and is an important control factor for the transportation of marine biochemical elements and the sedimentation of the seabed (Önol et al. 2013). Therefore, the determination of the vertical circulation and its dominant mechanism of the shelf sea are an important work to

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understand the physical and biogeochemical processes of the sea area and have a good application prospect for maintaining the high primary productivity of the sea area and developing and utilizing marine resources (Ozturk et al. 2015). The results show that the ocean surface circulation under the influence of the Indian monsoon shows obvious seasonal variation. The equatorial and southern waters show periodic changes of Wyrtki jet and southern Equatorial Countercurrent, as well as zonal motion of Southern equatorial current. The results show that the water area north of the equator shows a seasonal reversal in the direction of the general circulation: in the southwest monsoon, the southwest Indian coastal current, the southwest monsoon drift, and the north-facing East Indian coastal current are in the anticyclonic circulation; in the northeast monsoon season, the circulation direction is basically opposite (Saboori et al. 2012). The selected indexes not only reflect the functional state of the oxygen transmission system and energy metabolism system of the swimmers, but also indicate the adaptability of the swimmers to the amount and intensity of training during the training monitoring period. They can reflect the body function in time and prompt swimmers to adjust their state at any time, so as to complete the training task according to the plan (Sharifi et al. 2011). In the process of training, all kinds of indicators will fluctuate, but they can be set to the normal range, which shows that the training plan is reasonable and can fully stimulate the body of athletes (Tabari et al. 2014). In the pre-competition training monitoring, the changes of serum creatine kinase, blood urea, endocrine indexes, and immune-related indexes can reflect the effect of training and its effect on training. After the stage of pre-competition training, the athletes improve the aerobic and anaerobic metabolism ability in different degrees. Coaches organize this kind of training to give most athletes a special incentive (Vaghefi et al. 2019). This kind of sports training can also achieve the purpose of adaptation and recovery.

**Materials and methods**

**Data source**

The absolute dynamic elevation data comes from the aviso project, which transforms the sea level anomaly (SLA) into dynamic sea-level terrain, reflecting the geostrophic current component. The spatial resolution of abstract data type (ADT) data used in this paper is 0.25° × 0.25°. The time resolution is 7 days (Yu et al. 2018).

The velocity data from the Argos satellite tracking buoy were retrieved from the Coreoli Data Center of the Bureau of Ocean Development and Research and processed into velocity data every 6 h. The Argos buoy observed the depth of the buoy (15 m) at a shallow mixing velocity. The velocity of the mixing layer observed by the buoy is actually due to the influence of wind on objects, slippage, high-frequency current signals, and circulation information (due to the current caused by the direct wind in the upper mixing layer, eddy currents are generated at a depth of 15 m and large-scale release). Along the trajectory of the buoy, a 3D time window is used to filter out the high-frequency components. From this, we can know that circulation characteristics can be calculated by velocity.

**Video feature quantization design**

This paper introduces the proposed convolution feature quantization module, first reviews the Fisher vector theory, and then introduces how to estimate the probability density function used in the Fisher vector through the variational automatic encoder and how to optimize and finally extract the required Fisher vector descriptor from the encoder.

The Fisher vector theory considers the similarity of two local feature sets. The function has m parameters. The Fisher kernel between two sets X and Y can be expressed as:

$$K(X, Y) = G^X_θ F^{-1}_θ G^Y_θ$$

(1)

Since the matrix f is a positive semidefinite matrix, the Fisher kernel in formula (2.6) can be reformulated as an inner product in high dimensional space.

$$K(X, Y) = G^X_θ G^Y_θ$$

(2)

Among them:

$$G^X_θ = F^{-1}_θ G^X_θ = F^{-1}_θ \nabla_θ logu_θ(X)$$

(3)

In the concrete form, it will be defined as the famous Fisher vector. The dimension is equal to the number of generated model parameters, which is usually much higher than the dimension of the local feature descriptor, so the Fisher vector has a stronger description ability.

According to the formula (3), we can get that:

$$G^X_θ = F^{-1}_θ \nabla_θ logu_θ(X)$$

(4)

In the specific implementation, multilayer perceptron (MLP) is used as the encoder and decoder in FV-VAE. Since the dimension of the Fisher vector is directly related to the number of decoder parameters, only a single-layer decoder is used to reduce the dimension. In this way, the formula in algorithm (1) can be transformed into:
Encoder: $\mu_{x_1} \leftarrow \text{MLP}_\theta(x_1)$, 
Decoder: $\mu_{x_2} \leftarrow \text{ReLU} \left( W_\theta z_t + b_\theta \right)$ (5)

The parameters that constitute the encoder $\gamma_x$. The gradient vector of reconstruction loss is as follows:

$$\nabla x L_r(\theta; \mu^*, \phi^*) = \text{flatten} \left\{ \frac{\partial L_r}{\partial W_\theta} \right\} = \text{flatten} \left\{ \frac{\partial L_r}{\partial \mu_{x_1}} \cdot z_t, \frac{\partial L_r}{\partial \mu_{x_2}} \right\} = \text{flatten} \left\{ \frac{\partial L_r}{\partial \mu_{x_1}} \cdot \left[ z_t, 1 \right] \right\} = \text{flatten} \left\{ \left( \frac{\mu_{x_1} - x_t}{\sigma_x^2} \odot (\mu_{x_1} > 0) \right) \cdot [z_t, 1] \right\},$$ (6)

Considering that it is difficult to calculate the normalized Fisher information matrix (FIM) theoretically, the average value in the training set is used to replace the theoretical expectation of FIM:

$$F^*_{\theta} = \text{Ex}_{x \sim \mu} \left[ G_{\theta}^r G_{\theta}^* \right] \approx \text{mean}_x \left[ G_{\theta}^r G_{\theta}^* \right]$$ (7)

Research methods of swimmer training monitoring

Experimental monitoring method

On the spot monitoring of the pre-competition training of the swimmers participating in the pre-competition training of the swimming team Monitoring subject: 15 strong swimmers from the swimming team of the China swimming championship.

Monitoring purpose: physiological and biochemical indexes reflect the exercise load and intensity of athletes during pre-competition training. In order to evaluate the effectiveness of the competition and athletes before the competition, qualitative monitoring and evaluation of the functional state are carried out.

Design of load capacity and load intensity The monitoring time selected in the experiment is the appropriate training time before the competition (7 weeks before the competition). Before training before the competition, the athlete adjusted his body well and then focused on 2 weeks of high-standard training. It is divided into three stages: the first stage is the first 3 weeks, the second training stage is 4–5 weeks, and the last 2 weeks is the third training stage. The training time is from Monday to Saturday and closed on Sunday. After weekly training, the corresponding physiological and biochemical indexes will be measured the next Monday morning, and the measured indexes will be compared and analyzed.

Monitoring of physiological and biochemical indexes

According to the literature, we found some functional indexes related to pre-competition swimming training and referred to the scientific research of domestic sports physiology and biochemistry experts, as well as the scientific research of evaluating athletes’ performance, diagnosing fatigue, and carrying out sports, through the practical experience to improve and summarize. Talk with swimming coaches and scientific researchers and conduct interviews with them to identify indicators to monitor and evaluate swimmers’ pre-competition training according to the characteristics and operability of swimming events.

Blood routine; the anticoagulant test was performed with an sk990 red blood cell analyzer during 7:30–8:30.

Serum creatine kinase (CK): 7:30–8:30 every Monday. Venous blood was collected as an anticoagulant for examination by using an analyzer and matching reagent belt made in the USA and sk990 hematology analyzer made in Japan.

Blood urea (BU): every Monday morning, keep every week, from 7:30 a.m. to 8:30 a.m. before breakfast, take venous blood for the anticoagulation test.

Serum testosterone (T) and cortisol (c): every Monday morning from 7:30 a.m. to 8:30 a.m., venous blood was taken before breakfast for the anticoagulation test, then the levels of serum testosterone (T) and cortisol (c) were detected by radioimmunoassay, and blood (1,3,5,7) was used every 2 weeks.

Blood lactic acid (BLA): blood was drawn from the finger tip, and measured, and lactate levels were measured at an incremental load of 6 × 200 m freestyle. At the end of the exercise, 20 UL finger blood was drawn from the athletes every 200 m to test the lactic acid level. Ysi-1500 automatic blood lactic acid analyzer was used.

Mathematical statistics

Spss19.0 statistical software was used for statistical analysis of the measured data, and all the data were expressed as an average ± standard deviation (x ± SD). The indexes were compared by t-test in ANOVA; take $P < 0.05$ as a significant level, $P < 0.01$ as a very significant level.

Results

Surface circulation characteristics based on Oscar observations

Figure 1 shows the spatial distribution of monthly sea level absolute dynamic topography and Oscar surface water flow. It is used to show the seasonal characteristics of the surface circulation of the inspected water area, when comparing the two spatial distributions, except for the low latitude sea area (5° S to 5° N). In addition, the surface current is basically
along the dynamic terrain line, and the current in the sea area is mainly geostrophic. You can see that this is the current component in the narrow water area, especially near the equator (2° S to 2° N). The current vector intersects the dynamic terrain contour. There is a large angle between the two, which means that the non-formation current component is very low. Especially in the equatorial sea, the low latitude sea cannot be ignored.

Figure 2a shows that there are two large zonal velocity seasonal fluctuation regions corresponding to the seasonal fluctuation of the intensity of the monsoon and the equatorial jet, respectively. However, the seasonal variation of the meridional velocity component is relatively small. From the perspective of spatial distribution, there are two large seasonal variation regions in the north-south direction of the tropical East Indian Ocean (Fig. 2b). Extending from the east coast of the Indian peninsula to the east coast of Sri Lanka, this is a very valuable area, highlighting the seasonal variation of the East Indian Coast.

**Surface circulation characteristics observed by Argos**

Figure 3a shows the buoys deployed or entering the tropical East Indian Ocean. In addition to the buoy data with almost empty coastal waters, the buoy data in the high seas show different degrees of coverage, especially in the east of the equator, where the buoy data are relatively concentrated.

In the histogram, divide all buoy information by 1° × 1°. After a month, the grid is divided, and the object is to use the drift time of the buoy, so as to know the monthly surface circulation field (Fig. 4).
The spatial correlation analysis between the current velocity obtained by Argos buoy and the surface current of Oscar shows that (as shown in Fig. 5), the two velocity components are respectively related. The buoy and surface current field of ADT and Oscar are basically the same (the spatial correlation of meridian velocity in most waters is more than 0.6), and some main currents are relatively constant. This shows the reliability of the satellite remote sensing results.

First of all, in low latitude waters, especially when there is a main current near the equator, the surface circulation velocity observed by the surface drifting buoy is slightly higher than that observed by Oscar. The speed difference between the two dates is more important. It can be seen from the earlier results that the remote sensing data from buoys and satellites have the unique characteristics of reflecting the characteristics of surface circulation. In order to describe the various characteristics of surface circulation comprehensively and systematically, it is necessary to combine them when analyzing the characteristics of surface circulation.

The changes of equatorial current and its surface circulation in the South China Sea are mainly reflected in the periodic appearance of the Wyrtki jet, the South Equatorial Counter Current, and the North–South Movement of the South Equatorial Current. The direction of the large-scale circulation in the sea area north of the equator depends on the season: during the southwest monsoon, the West Indian Ocean coastal current, the southwest monsoon drift, and the East Indian Ocean coastal current form a circulation system.

In order to show the seasonal variation characteristics of the East Bay mouth to the ocean more clearly, Fig. 6a, b shows the time series of meridional velocity V in the zonal section (5.5°N) of the bay mouth. The contour (color map) represents the meridian velocity V on the surface of Oscar (buoy).

During the northeast monsoon, buoys can enter and leave the bay mouth in three ways. There are two routes (19 in total) to the west of the bay mouth. The buoy road along the western border of M Bay and the coast of Sri Lanka exits to the estuary of the Gulf through the coastal flow of the East Indian Ocean and finally to the waters of the southern part of the Indian Ocean peninsula. Another buoy islands flow from the bay mouth along the drift path of the northeast monsoon, as shown in Fig. 7.
Fig. 4 Monthly mean sea surface absolute dynamic height (isoline, unit: cm) derived from buoy data in tropical East Indian Ocean surface circulation (vector, unit: m/s)

Fig. 5 The spatial correlation between the velocity of Argos buoy and the surface flow of Oscar. a The zonal velocity component U. b Meridional velocity component V
Thermohaline structure of ocean surface circulation

According to the monthly distribution of surface temperature of soda (Fig. 8), the sea surface temperature of the tropical East Indian Ocean is high throughout the year, which is basically above 28°C.

The distribution of surface salt in the whole space is basically the same (Fig. 9), which is usually higher in the West and lower in the East. The Arabian Sea has a high salinity, with a maximum salinity of more than 36; the salinity of M Bay is low, and the salinity near the Irrawaddy River in the Andaman Sea is less than 32. The water surface difference between the Arabian Sea and M Bay is about 3.

The surface salinity near the equator shows a large zonal gradient. The seasonal standard deviation chart of surface salt (Fig. 10) shows that the seasonality of surface salt varies greatly in most of the water bodies examined. In the lower latitudes, the range of high salinity tongue changed greatly. The longest...
period of east wind is from May to June and from November to December, which reflects the process of using the Wilki jet to transport high salt water.

Analysis of swimmer training monitoring results

Table 1 shows the monitoring results of endocrine-related indexes of male swimmers during pre-competition training.

| Index       | Mean Value |
|-------------|------------|
| Testosterone T | 622.21 ng/dl |
| Cortisol C    | 19.21 ng/ml  |
| T/C           | 32.64 ng/ml  |

Before training, the average T/C value of male athletes was 613.58 ng/dl, 16.26 ng/ml, and 37.74 ng/ml.

We observed the data in the first week: T and C showed an increasing state, while T/C showed a downward trend. In the third week of training before the start of the competition, the training intensity and load were basically maintained at the beginning of the training and showed the status quo of continuous training. When it comes to 5 weeks, it has shown the strongest state, and the data show a declining state. There was a significant difference compared with the third week ($P < 0.05$).

As shown in Table 2, the average serum testosterone T of female swimmers during pre-competition training is 59.41 ng/dl, the average serum cortisol C is 23.23 ng/ml, and the average T/C is 2.57. As can be seen from the table, the change is almost the same for men. In the first week after training, T and C showed an upward trend, while T/C showed a downward trend. In the third week of training before the competition, the training intensity and load were basically maintained at the...
beginning of training, while T and C continued to show an upward trend. T/C continues to show downward trend.

Figure 12 shows the monitoring results of endocrine-related indexes of female swimmers during pre-competition training.

| Table 1 Monitoring results of serum testosterone, serum cortisol, and T/C value of male swimmers during pre-competition training |
|---|---|---|
|   | T (ng/dl) | C (ng/ml) | T/C |
| Before training | 613.58 ± 106.22 | 16.26 ± 3.45 | 37.74 ± 7.45 |
| Week 1 | 627.35 ± 94.21 | 18.59 ± 4.83 | 33.75 ± 6.58 |
| Week 3 | 634.26 ± 89.93 | 22.25 ± 8.43 | 28.51 ± 7.54 |
| Week 5 | 601.33 ± 102.57# | 21.31 ± 5.32 | 28.22 ± 9.45* |
| Week 7 | 633.00 ± 93.75# | 18.10 ± 7.89 | 34.97 ± 8.25# |
| Average value | 622.21 ± 97.31 | 19.21 ± 6.45 | 32.64 ± 7.85 |

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Table 3 shows the monitoring results of immune cell changes of female swimmers during pre-competition training. Table 4 shows the monitoring results of immune cell changes of male swimmers during pre-competition training.

As shown in Fig. 13, during pre-competition training, the number of white blood cells did not exceed the normal reference range. After two times examination, the number of white blood cells, neutrophils, and monocytes basically did not change. Through the exercise before the competition, WBC fluctuated slightly, and there was no obvious change during the strengthening or adjustment period.

Discussion

Analysis and discussion on the changes of the related indexes of the oxygen transferability of swimmers

The average Hb value of male swimmers during pre-competition training was 155.64 g/L, and RBC was 4.89 × 1012/L; the RBC average for female swimmers was 4.47 × 1012/L, and the average Hb value is 141.29 g/L. The hemoglobin index is mainly used to evaluate the athletes’ response to the intensity and function of the exercise load and the exercise load during the specific training period. If you do high-intensity training, it will have a bad effect on the body’s functions and some indexes. However, hemoglobin will not decrease further until the body is adapted to the load. If hemoglobin levels are significantly reduced, it means that our load is too heavy or our body is tired, then we should do some endurance training to improve hemoglobin content and adjust our load (Abbaspour et al. 2012).

Before pre-competition training, the hemoglobin and red blood cell count of male and female swimmers were normal. With the increase of exercise, the number of hemoglobin and red blood cells decreased slightly in the first and second weeks (Amiri and Eslamian 2010). The training begins this stage as part of the adaptation phase of pre-competition training (1 to 3 weeks). At this point, the training load is very low, and the athletes’ response to the load is very low. At this time, the hemoglobin and red blood cell count change very little. Hemoglobin and red blood cell count showed a trend of recovery at 3 weeks after exercise.

In summary, the results of this study show that athletes’ hemoglobin can reflect a load of exercise, and the hemoglobin changes with the amount of exercise. The red blood cell count may also reflect the exercise. MCV and RDW did not change significantly during pre-competition training (Basha et al. 2015). The peak level of Hb, RBC, and HCT of male and female athletes gradually reached their peak level before all pre-competition training.

Analysis and discussion on the change of blood urea (BU) of swimmers

Blood urea (BU) is usually used to reflect the exercise load during exercise. After exercise, the blood urea of the human body changes in different degrees. However, if the urea in human blood changes within half an hour, the exercise time will be more than half. After a few hours, the blood urea level in the body increased significantly.
After a certain amount of exercise, the blood urea of athletes increased significantly in the morning’s test, but after rest or recovery exercise, the blood urea decreased to the level before exercise, which indicates that the exercise plan is heavy. After a period of adjustment, if the blood urea decreased but did not fall to the calm level, it means that the exercise load is not very reasonable (Bucchignani et al. 2018).

The results show that the average BU of male swimmers is 5.23 mmol/L and that of female swimmers is 4.29 mmol/L. The overall level is not high. In the first week of pre-competition training, BU values of both male and female swimmers increased slightly (Draxler et al. 2001). The amount of exercise this week stimulated the athlete’s body. Since the body is still adapting to the load, the increase in blood urea is relatively small. In the first 2-3 weeks of training, the BU of male and female athletes decreased slightly. This shows that athletes are gradually adapting to their current training load. In the fourth week of training, the BU value of male and female swimmers increased significantly (Droogers et al. 2012). This is the highest value in the pre-competition training stage, which is very different from the pre-competition training (P), and it also maintains this level in a few days, so this method is very good.

**Analysis and discussion on the changes of serum creatine kinase (CK) in swimmers**

After exercise, serum CK changes obviously, which indicates exercise intensity to a certain extent. Due to the high sensitivity of serum CK changes, it has many uses in exercise practice. This study continuously monitored the changes of serum CK of female and male athletes during pre-competition training. The purpose of this study is to understand the body’s ability to withstand stress stimulation and recover after exercise to observe whether the intensity of exercise load is appropriate (Emadodin et al. 2019).

The research shows that the tendency of male and female swimmers to change CK levels during pre-competition training is basically the same. Overall, the average CK value of male swimmers was 198.71 mmol/L and that of female swimmers was 149.40 mmol/L. Usually, if they are playing, the serum CK will be lower. During the last training period, there is no obvious accumulation of fatigue, and the athletes’ exercise load intensity is adjusted appropriately. In the first week of training, the CK level of male and female swimmers increased. This is the process of training before the game because it can increase the CK in the serum.

Serum creatine kinase can reflect the stress intensity of sports training. During the pre-competition training, the

### Table 3: Monitoring results of immune cell changes of female swimmers during the pre-competition training period

|          | N | WBC (×10%/L) | NEUT (%) | LYMPH (%) | MONO (%) |
|----------|---|--------------|----------|-----------|----------|
| Before training | 7 | 6.28 ± 1.72  | 51.88 ± 5.71 | 43.82 ± 5.39 | 4.30 ± 0.89 |
| Week 1    | 7 | 5.96 ± 1.01  | 50.36 ± 6.02 | 45.06 ± 6.55 | 4.58 ± 1.81 |
| Week 3    | 7 | 5.58 ± 1.44  | 57.03 ± 4.35 | 36.77 ± 6.26 | 6.20 ± 2.35 |
| Week 5    | 7 | 5.33 ± 1.02  | 59.33 ± 9.74 | 33.85 ± 8.78 | 6.82 ± 1.31 |
| Week 7    | 6 | 6.34 ± 1.24  | 51.52 ± 6.66 | 41.14 ± 5.44 | 7.34 ± 1.47 |
| Average value | 6 | 6.20 ± 1.26  | 53.75 ± 7.51 | 39.73 ± 7.45 | 6.52 ± 1.99 |
average serum creatine kinase of male swimmers was 198.71. The average value of serum creatine kinase in swimmers was 149.40 mmol/L (Fazel-Rastgar 2020). These data are still relatively low, indicating that they have adapted to the training load and recovered their function.

Analysis and discussion on the changes of endocrine index of swimmers

Testosterone mainly promotes the synthesis of protein in vivo. Promoting synthesis and metabolism is the most important hormone in the human body. In contrast, cortisol is the hormone that promotes protein decomposition and catabolism in vivo (Ghiami-Shamami et al. 2018). Exercise can lead to changes in serum testosterone and cortisol. High-intensity stimulation at a moderate level can increase the serum testosterone and cortisol in the body. At this time, the catabolism and synthetic metabolism of the human body also increased (Karami 2019). As this intense stimulation continues to work on the human body, serum testosterone decreases and cortisol increases.

Therefore, sports will have a significant impact on the level of testosterone in the body. Due to the imbalance of the hypothalamic–pituitary–gonadal axis during long-term exercise, the resting serum testosterone level of athletes is lower than that of the general population. Long time heavy load and heavy training will reduce the level of testosterone in athletes’ serum and correspondingly, reduce the strength, muscle quality, and the ability to repair the physical injury of athletes.

Therefore, the monitoring of serum testosterone in athletes has a very positive effect on the evaluation of training load and intensity.

In the early stages of training, T/C scores can be used to detect training intensity. Athletes’ training stress is also reflected in their T/C scores. Higher T/C levels can increase protein synthesis and muscle in the body, thus improving athletes’ ability to recover from their functional state. The decrease of the T/C level indicates that the catabolism of the human body is increased. If the T/C value continues to drop by more than 30%, care must be taken to avoid overtraining (Lelieveld et al. 2012).

The previous analysis shows that the serum testosterone and T/C levels of athletes may reflect the pressure of gradual exercise. The T/C value will also change with the change of training load. The pre-competition training increased the alcohol level in the body in response to the stimulation of testosterone and serum cortical exercise load during the strengthening stage. The T/C ratio of male and female athletes initially decreased significantly then returned to the pre-competition level. This shows that the endocrine function of athletes has reached a good state, and the pre-competition training has achieved the purpose of stimulation.

Analysis and discussion on changes of immune indexes of swimmers

Sports training also has some effects on the body’s immune system. After a long period of high-intensity exercise, the

### Table 4 Monitoring results of immune cell changes of male swimmers in the pre-competition training period

|        | N  | WBC (×10^9/L) | NEUT (%) | LYMPH (%) | MONO (%) |
|--------|----|---------------|----------|-----------|----------|
| Before training | 8  | 6.79 ± 1.02   | 55.13 ± 8.01 | 40.70 ± 8.41 | 4.18 ± 1.24 |
| Week 1  | 8  | 5.61 ± 0.79   | 42.98 ± 19.36 | 40.21 ± 18.18 | 4.33 ± 2.08 |
| Week 3  | 8  | 6.87 ± 1.64   | 66.90 ± 10.66 | 26.99 ± 10.47 | 6.11 ± 1.33 |
| Week 5  | 8  | 5.58 ± 0.87   | 64.23 ± 3.95  | 28.93 ± 4.04  | 6.78 ± 1.17  |
| Week 7  | 8  | 6.35 ± 1.29   | 51.35 ± 4.26  | 40.55 ± 3.89  | 8.10 ± 1.79  |
| Average value | 8  | 6.27 ± 1.23   | 57.18 ± 13.04 | 34.98 ± 11.44 | 6.39 ± 2.27  |
number of white blood cells (WBC) has decreased, and the human body’s immunity will also decline. At this time, the body is prone to disease. Symptoms such as ill-health can have a serious impact on health and exercise (Leleiveld et al. 2016). Therefore, the immune function of athletes should be monitored in sports training. If monitoring shows a sharp decrease in white blood cells, targeted treatment should be carried out.

This indicates that individual athletes may have an inflammatory reaction and need immediate treatment. It is found that the white blood cell count of male and female swimmers in pre-competition training does not exceed the normal reference range. The number of white blood cells, neutrophils, and monocytes did not change. WBC fluctuated a little, and there was no obvious change during strengthening or adjustment. This shows that the immune system of athletes is relatively stable in pre-competition training, and sports training has no effect on athletes.

### Analysis and discussion on the change of lactic acid speed curve of swimmers

The concentration of lactic acid in the blood will change with the intensity of exercise. First, it rises slowly and then sharply after the transition period. The turning point or change range of 4 mmol/L is the evaluation of aerobic intensity (Madani 2014). The correct value of metabolic capacity is called lactate threshold. Swimming events using lactate threshold swimming speed are called lactate threshold intensity training, and are widely used in aerobic exercise.

The source of the lactic acid speed curve is the range of after training. It can effectively show the training effect and then know the aerobic metabolism. Under normal circumstances, if the lactic acid rate curve moves to the right after training, it shows that the exercise effect is good. If the lactic acid rate curve moves to the lower after training, it will produce more lactic acid under the same level of exercise intensity, thus reducing the aerobic metabolism of athletes and reducing the effectiveness of training. If the body’s lactic acid rate curve does not change after exercise, it means that exercise does not affect our body. In short, the lactic acid speed curve can better reflect whether and how much the body’s aerobic metabolism improves during exercise.

### Conclusion

In this study, the vertical profile time series of vertical circulation is given by using anchor system observation and dynamic diagnosis of vertical velocity at a fixed point. In the next work, the three-dimensional structure and distribution characteristics of vertical circulation are given by using the Omega equation and eSQG diagnosis method, combined with section observation and high-resolution satellite observation, and the differences of different dynamic diagnosis methods are compared and analyzed. At the same time, the vertical motion and mesoscale vortex process of a tropical storm can be analyzed in detail by using a numerical model. In this study, all subjects examined were trained for the first time. The training was unable to achieve very satisfactory results due to lack of experience. However, the monitoring of physiological and biochemical indicators shows that advanced training can improve the oxygen-carrying capacity of athletes. After advanced training, the indicators such as CK have decreased significantly, and the physical function of athletes was restored to normal essentially. As a result, the athletes’ performance did not improve much. The reason is planning and focusing too much on maintaining the effectiveness of training. Let the athletes receive further more intense training without fully recovering. Therefore, some methods of training swimmers need further research.

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### Declarations

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

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