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# Characteristics of Athletes' Psychological State before Competition and the Correlation Analysis of the Psychological State of Athletes of Different Levels

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**Abstract**

This article analyzes the mental state data of athletes, and concludes that depression has a strong correlation with mental states such as potential risk of suicide and anxiety. Static features include some basic attributes of athletes, which are related to depression through hypothesis testing and regression analysis. Dynamic features are constructed from the mental state data generated by athletes on the playing field, which can represent athletes' consumption related to changes in athletes' behavior. This paper analyzes the principle of the interactive multi-model algorithm in more detail, and solves the problem of the uncertainty of the target athlete's mental state measurement points and the target athlete's mental state. Aiming at the problem of the target athlete's mental state loss during the evaluation process, the expanded correlation gate is applied to this algorithm. When the target athlete's mental state is manoeuvring and no effective measurement can be detected in the correlation gate, the correlation gate gradually expands. At the same time, in order to reduce the computational complexity of the new algorithm as much as possible, the pre-defined sampling interval method is used to adaptively adjust the evaluation sampling period to balance the judgment accuracy of the athlete's mental state. The results of the study show that the self-confidence of each athlete representative team is generally higher, which is basically above the average level. Only a few teams have not reached the average level of self-confidence. No difference is found in the self-confidence subscale between men and women's volleyball teams. In the individual failure anxiety subscale, the top three teams are all lower than the overall average, and the individual failure anxiety of other athlete teams is higher. Physical anxiety levels of the top three teams are below the overall average level, and the level of physical anxiety is not high. The fourth to sixth places are all above the average level, and the level of physical anxiety is high. The biggest obstacle for high-level athletes to form an ideal pre-match state is that athletes have a high degree of anxiety about social expectations. All high-level sports teams continue to maintain this high-confidence pre-match mental state, which helps athletes experience a good level of arousal before the game.

**Keywords:** athlete; mental state characteristics; interactive multiple models; fast data association; expanded association gate

## Introduction

In the era of rapid development of competitive sports, athletes and players rigorously train themselves and compete with each in terms of physical fitness, technology, and tactics. The key to the victory or defeat in a competition is often the level of psychological stability shown on-the-spot or during performance. Athletes in good psychological shape can increase a team's chance of victory. Studies have shown that targeted pre-match psychological training can effectively improve an athletes' performance (Cheban Y, et al 2020). The pre-match mental state, as an important factor that constitutes the psychological quality, provides an effective theoretical basis of training in the psychological training of athletes. The evaluation of athletes' pre-match emotions can effectively carry out relevant training for athletes. Event athletes adopt different specialized trainings. In previous studies, there are many propositions to the effect that mental function training can promote the growth of performance, and that performance has a direct relationship with psychological factors (Steinbrink K M, et al 2020). The pre-match psychological adjustment has a stronger influence on the athlete's performance (Lisenchuk G, et al 2019). Therefore, pre-match emotions are, to a certain extent, an important component of mental skills.

At present, many countries attach great importance to the study of athletes' mental states before competitions (Reardon C L, et al 2019). They believe that the pre-match mental state is an important factor determining the ability of high-level athletes to achieve good results. That is to say, the duel between high-level athletes is not just a contest between physical stamina and skills, but more a 'game' of mental skills. Foreign countries attach great importance to sports psychology. Almost every professional team will be equipped with a psychologist. The duties of psychologists mainly include mobilization before the game and recovery after the game. However, in our country, sports psychology started late, and for the most part, sports psychology has not been paid the attention it merits. Later, sports psychology developed relatively rapidly, and a large number of research results appeared in the academic world (Soulliard Z A, et al 2019). Some sports psychology research results are applied to competitions, and relatively satisfactory results have been achieved. At present, the government is seen attaching great importance to the application of sports psychology in competitive sports. During our country's participation in the Olympics and

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World Championships, local sports psychology experts have been conducting evaluation services on the front line for a long time, and according to the characteristics of each different project, a special psychological training program enables athletes to quickly accept this adjustment method. After the athletes undergo psychological training, their competitive state is seen to be significantly improved, which provides a guarantee for the athletes to obtain the best competitive state in the game (Codonhato R, et al 2018).

The purpose of this paper is to analyze and construct the characteristic vector of the mental state perception model and explore the correlation between the inherent attributes of people and the depression state, that is, the static characteristic analysis of the depression state perception model. This study analyzes whether there is a correlation between each factor and the depression state through single factor binary logistic regression, Secondly, the author synthesizes the results of each single factor analysis, comprehensively analyzing the relationship between each factor and the depression state from the multi-factor binary logistic regression. Finally, the score of the depression sub-item of the original symptom self-rating scale is used as the target athlete's mental state, that is, the degree of depression, and the multiple logistic regression model is used to consider whether each factor is an influencing factor of the degree of depression. Based on the above analysis results, the characteristics of the depressive mental state perception model are finally established. This article describes the evaluation of multiple athletes in a clutter environment. First, it introduces the principles of the first generation of multi-model and interactive multi-model algorithms for athlete evaluation. For the problem of judging the mental state of multiple athletes, the introduction of athletes' mental state data correlation is effectively combined with the interactive multi-model algorithm, and the algorithm simulation is carried out. Aiming at the problem of the target athlete's mental state loss, the method of expanding the correlation gate is proposed to remedy the problem. Moreover, the adaptive sampling period strategy is used to balance the algorithm evaluation accuracy and calculating the amount. In particular view of high-level sports teams in colleges and universities, we organize athletes to collectively engage in beneficial entertainment activities before the game to relax. At the same time, coaches should also pay attention to the athletes' psychological trends, communicate promptly when problems are found, and ensure that athletes enter the game without psychological burden. Before the competition, we organize athletes to familiarize themselves with the environment of the competition field and surrounding environmental conditions and do sufficient preparation activities to make the body and mind quickly adapt to the environmental conditions of the competition field and enter the ideal psychological state of the game. By studying the psychological status of different levels of athletes, we can explore the common problems faced in the psychological development of the high-level volleyball teams in the autonomous region and put forward meaningful and constructive suggestions for the scientificalization of the overall training of high-level volleyball teams. This study seeks to put forward new ideas and countermeasures for the training mode of college volleyball teams and hopes to provide meaningful references for college volleyball teams in the psychological training of athletes.

## Related work

There are several studies focusing on pre-match psychological training (Veysel T et al 2019). Existing research mainly focuses on the influence of psychological training on technical tactics. Scholar points out in "The Psychological Characteristics of Basketball Players and the Methods of Pre-match Psychological Training" that to improve the pre-match mental ability of basketball players, pre-match training is an indispensable means (Doğan U. et al 2021). The precondition of pre-match training is to improve the athletes' athletic level, for which simulation training must be taken seriously. It also points out that basketball is a sport that requires high level of skill, physical fitness, and psychological quality from athletes (Dongoran M F, et al 2020). Other scholars posit that when it comes to adjusting the mental state of young volleyball players, there are multiple factors to study that affect the pre-match mental state of young volleyball players, which are divided into subjective factors and objective factors (Leźnicka K, et al 2017). The subjective factors relate to the influence of external factors or the environment. The objective factor is mainly that the psychological development of young athletes is still immature, unable to form effective psychological skills, and has not formed its own set of effective programs for emotional control and regulation. Therefore, young athletes should not only conduct physical and technical training, but also pay attention to psychological training.

After conducting related psychological research on Taekwondo athletes, related scholars that Taekwondo is a training method that combines muscle sensation and motor appearance characteristics (Rogowska A M. et al 2020). Due to the fierceness of Taekwondo in competitions, athletes must have high-intensity attention and tenacity. The fighting spirit can win the game, which requires athletes to strengthen the training of psychological skills in their usual training. When Scholar conducts pre-match psychological training for female weightlifters, he uses the "inverted U-shaped hypothesis" to train the athletes' mental abilities (Sukys S, et al 2020). The basic idea is to determine the basic motivation of the competition, make relevant adjustments to their own emotions, enhance your own experience of success, and train athletes with the best attention and position themselves reasonably (Wang C H, et al 2020).

In the pre-match psychological training of aerobics athletes, the researchers analyze the pre-competition psychology of aerobics athletes (Mach N, et al 2021). They find psychological training to be a highly complicated

process. A more thorough training plan after careful consideration is combined with skill training to carry out related training methods for mental skills (Vysochina N, et al 2018). In the end, he concludes that psychological training can coexist with the teaching form, which can help improve the relevant level of psychological training. In "Athletes Pre-match Psychological Training", it is believed that pre-match psychological training is currently receiving attention, leading to the increasing trend to equip sports teams with psychologists. Future training should be tailored to individual athletes' different personalities and psychological conditions. In addition, it is necessary to allow athletes to establish their own good pre-match psychological activities to develop their ability to deal with emergencies on the field, and in doing so, ensure that their psychological training continues to achieve the desired effect in the short and long-run.

In terms of psychological training, foreign researchers consider the athlete's individual psychological characteristics, and conduct related training according to the athlete's diverse psychological states (Kim M, et al 2020). Some athletes use the method of self-adjustment training, and some athletes carry out related training under the encouragement of coaches. Psychological training should take stock of the personality characteristics of different athletes and be carried in different time periods. The psychological characteristics of humans show a certain degree of plasticity, that is, athletes can be shaped through scientific training methods. Psychological skills training can effectively help athletes adapt to the needs of the game and create their own style on the sports field. The means of pre-match psychological training must be combined with their own special events, so that specialized training can be provided. Relying on such special training, athletes can combine psychological training with their own skill level, which can potentially prove beneficial to their own development (Markati A, et al 2019). Psychological skills are an indispensable part of modern competitive sports as they have a deterministic influence on an athletes' physical skills and psychological state. Therefore, mental skills training should be encouraged as a mainstream training method in the future.

Regarding the study of pre-match mental state, there are many related research results at home and abroad (Andrade A, et al 2019, Özdemir N. 2019 and Berriel G P, 2020). Among them, it is generally believed that pre-match mental state is one of the main factors affecting one's normal performance. Others have conducted relatable research on the mental state of outstanding domestic female Taekwondo athletes. For this purpose, they use psychological tests and on-site observation methods to test the mental state of outstanding Taekwondo athletes. The results show that there are obvious differences in the mental state before the game, but the conclusion part highlights the deficiencies of the research, that is, the research sample is too small, and the test time is short (Trabelsi K, e al 2020).

Researchers conducting analysis on the psychological adjustment of gymnasts before the competition find that in international competitions, not only are the skills and physical fitness of the athletes very high, but the mental state is also high, especially during the competitions (Parma J O, et al 2019 and Jewett R, et al 2019); establishing, among other things, that reasonable guidance to athletes before the game, an understanding of themselves and having a strong psychological state or profile, are the keys to success in the game (Cerea S, et al 2018). Scholar demonstrates that when conducting psychological tests on different levels of Taekwondo athletes, it is found that different levels of athletes have different pre-match psychological adjustments, and for different athletes, the pre-match psychological adjustment methods must be different (Gerber M, et al 2018).

Relevant scholars posit in the "Experimental Research on Pre-match Psychological Training of Young Male Discus Athletes" that pre-match psychological training can eliminate the nervous state of athletes before the game, and pre-match psychological training can also improve competition performance (Papa L, et al 2019 and Casto K V, 2019). If athletes can receive long-term psychological training, it can also improve the athlete's ability to resist pressure on the field and have a certain influence on the formation of the athlete's personality. Therefore, at the end of the article, it is suggested that athletes should carry out related mental ability training (Wagner III K J, 2020 and Kassim A F M, et al 2018). Scholars conduct related investigations on the mental state of track and field athletes in Henan colleges and universities before the game (Reale R, et al 2018). They found that the mental state of athletes before the game is generally divided into the following four types, namely, excessive tension, combat readiness, indifference, and blindness. It also suggests corresponding measures that should be undertaken to solve these problems. At the end of the article, it gives suggestions on the pre-match psychological training of track and field athletes. That is, physical training, technical and tactical training and psychological training are combined to eliminate unfavorable factors before the game. The influence of negative factors makes the athletes' competitive state reach the best (Bateman A, 2019, Roberts S S H, 2019, and Donohue B, et al 2019).

## Structural Analysis of Athletes' Pre-Match Mental State Perception Characteristics

### Characteristic Analysis of Single Factor Binary Logistic Regression of Depressive Factors

For the influencing factors of depression, first the researcher considers the correlation between a single factor and the depression state. Considering the analysis of the correlation between the athletes' mental state data by binary logistic regression, the way to deal with the depressive state is to consider the symptom self-rating scale depression sub-item score greater than 26 as having

depressive symptoms. If the depression sub-item is less than or equal to 26, it is considered that there is no depressive symptom, and it is set to 0. For attributes of discrete categories, the variable needs to be dummified and converted into N 0-1 variables, where N is the number of categories of the discrete attribute. At the same time, because the sum of N 0-1 variables is 1, to avoid the problem of co-occurrence, it is necessary to select any one of the components as the base variable and add a constant term.

For the discrete attribute of gender, firstly, it is numerically processed, and male and female are mapped to 1, 0 respectively, and cross-frequency analysis and dummization are performed. The results are shown in Table 1. From the cross-frequency analysis matrix, it can be easily seen that there is no major connection between gender and depression, and there is no significant difference in the number of depressions between men and women.

**Table 1.**

*Analysis and Processing of Mental State Data of Gender Athletes*

| **Analysis of crossover frequency between gender and depression** | | | | **Examples of dummy data** | | |
|---|---|---|---|---|---|---|
| **Number of people** | | Gender | | Sequence | sex_0 | sex_1 |
| | | 0 | 1 | 0 | 0 | 1 |
| **Depression** | 0 | 880 | 3301 | 1 | 1 | 0 |
| | 1 | 168 | 585 | 1 | 0 | 0 |

We select sex_1 as the base variable, add the constant term intercept, and use the depression result as the label. The logistic regression output results obtained are shown in Table 2.

**Table 2.**

*Logistic regression results of gender and depression*

| **Dependent variable** | **Depression** | **Number of samples** | **5144** |
|---|---|---|---|
| **Model** | Logistic regression | Residual degrees of freedom | 5137 |
| **Method** | MLE | Number of model parameters | 1 |
| **Date** | 2020-11-11 | False determination coefficient | 0.00011 |
| **Time** | 09:30:40 | Log likelihood | -2011 |
| **Whether to integrate** | Yes | LL-Null | -2007 |

From the results in Table 2, the gender difference is not statistically significant for depression (P value is greater than 0.05), which also confirms the results of gender crossover frequency analysis.

**Table 3.**

*Logistic regression results of categories and depression*

| | **Regression coefficients** | **Standard error** | **z value** | **P value** | **[0.022 0.964]** |
|---|---|---|---|---|---|
| **account_type_2** | -0.15 | 0.25 | -0.61 | 0.54 | -0.66 0.34 |
| **account_type_3** | -0.19 | 0.09 | -1.92 | 0.05 | -0.34 0.00 |
| **account_type_4** | 0.05 | 0.18 | 0.26 | 0.79 | -0.33 0.43 |
| **intercept** | -1.58 | 0.07 | -20.76 | 0.00 | -1.73 -1.43 |

The author selects account_type_1 as the base variable, adds the constant term intercept, and uses the depression state as the label. The logistic regression output results obtained are shown in Table 3. From the results in the table, there is a statistically significant difference between being in town and whether it is depressed (P value is equal to 0.05), and there is no statistical significance between other categories and whether it is depressed (P value is greater than 0.05).

**Analysis of Characteristics of Multivariate Binary Logistic Regression of Depressive Factors**

Combining the above-mentioned single-factor binary logistic regression results, this study comprehensively considers the relevance of these factors to the depression state taking gender, age, discipline, candidate type and ethnicity as dependent variables. At the same time, to avoid the problem of collinearity, for each discrete attribute, one of the dummy variables is selected as the base variable, and a constant term is added; with depression as the label, the results of multi-factor binary logistic regression are shown in Table 4. The structure of the table is consistent with the results of the above-mentioned single factor logistic regression. From Table 4, ethnicity is an influencing factor of depression (P value is less than 0.5), and other factors are not statistically significant (P value is greater than 0.5). It shows that the attribute of ethnicity is more important for the dependent variable of depression than other attributes.

**Table 4.**

*The analysis of multivariate binary logistic regression on the depressive factors*

| | **Regression coefficients** | **Standard error** | **z value** | **P value** | **[0.022** | **0.971]** |
|---|---|---|---|---|---|---|
| **sex** | -0.04 | 0.1 | -0.5 | 0.65 | -0.2 | 0.15 |
| **age** | -0.05 | 0.06 | -1 | 0.3 | -0.17 | 0.05 |
| **score** | 0 | 0.01 | -0.67 | 0.5 | -0.03 | 0.02 |
| **batch_0** | 0.12 | 0.11 | 1.81 | 0.07 | -0.01 | 0.4 |
| **subject_1** | 0.4 | 0.41 | 0.98 | 0.32 | -0.39 | 1.2 |
| **subject_2** | -0.56 | 0.48 | -1.2 | 0.3 | -1.45 | 0.34 |
| **account_type_2** | -0.11 | 0.26 | -0.34 | 0.67 | -0.6 | 0.37 |
| **account_type_3** | -0.16 | 0.08 | -1.77 | 0.08 | -0.3 | 0.01 |
| **account_type_4** | 0.12 | 0.21 | 0.54 | 0.6 | -0.2 | 0.52 |
| **nation_0** | 0.34 | 0.14 | 2.3 | 0.02 | 0.05 | 0.58 |
| **intercept** | -0.16 | 1.34 | -0.12 | 0.91 | -2.8 | 2.76 |

**Analysis of Multiple Linear Regression Characteristics of Depression Influencing Factors**

The above result is a binary logistic regression result of single factor and multiple factors. In fact, the depression sub-item of the Symptom Self-Rating Scale is a continuous value, indicating different degrees of depression. Therefore, it is necessary to use a multiple linear regression model to consider the relevance and degree of relevance of factors. In the linear regression analysis, gender, age, scores, discipline, type of candidates, and ethnicity are used as dependent variables, and the depression score in the self-rating symptom scale is used as the dependent variable. The results of multiple linear regression are shown in Table 5. The upper part of Table 5 is the parameter results of the model, which contains the regression coefficients, standard errors, t-values and P-values of each independent variable, and the confidence intervals of the regression coefficients. The candidate's type, ethnicity, and discipline are correlated with depression scores (all P values are greater than 0.05), and the correlation between the remaining independent variables is relatively weak (all P values are less than 0.05).

**Table 5.**

*Multiple linear regression analysis of depressive factors*

| | Regression coefficients | Standard error | t value | P value | [0.022 | 0.971] |
|---|---|---|---|---|---|---|
| **sex** | -0.08 | 0.61 | -1.5 | 0.62 | -0.24 | 0.12 |
| **age** | -0.045 | 0.05 | -1.2 | 0.36 | -0.14 | 0.25 |
| **score** | -0.01 | 0.01 | -0.63 | 0.57 | -0.05 | 0.12 |
| **batch_0** | 0.13 | 0.13 | 1.82 | 0.07 | -0.05 | 0.41 |
| **subject_1** | 0.42 | 0.42 | 0.91 | 0.35 | -0.35 | 1.26 |
| **subject_2** | -0.65 | 0.45 | -1.52 | 0.31 | -1.41 | 0.34 |
| **account_type_2** | -0.14 | 0.21 | -0.44 | 0.62 | -0.62 | 0.36 |
| **account_type_3** | -0.16 | 0.07 | -1.67 | 0.07 | -0.34 | 0.11 |
| **account_type_4** | 0.02 | 0.24 | 0.74 | 0.63 | -0.25 | 0.55 |
| **nation_0** | 0.24 | 0.16 | 2.5 | 0.03 | 0.07 | 0.53 |
| **intercept** | 1.06 | 1.31 | 1.12 | 0.93 | -2.85 | 2.59 |

**Social Relationship Characteristics**

The active level of social relations is an important indicator reflecting a person's introversion and extroversion. Active social relations indicate that the athlete is relatively lively, willing to socialize, and his or her number of friends is likely to be high. The personality is relatively withdrawn, not good at or willing to socialize. For individuals with a relatively withdrawn personality type, are not unable to express and accumulate stress and negative emotions. Over time, when the psychological pressure reaches the threshold that they cannot bear, it will lead to mental breakdown and eventually depression.

Since there is no scientific quantitative method for the degree of social relationship activity, this article will directly use the number of friends to characterize the athlete's social activity. That is, the higher the number of friends, the more socially active the athlete is and vice versa. The mining of the number of friends is based on the co-occurrence analysis of the athlete's behavior and the psychological state of the athletes. Based on the assumption that if two people are friends, the friend relationship here is a two-way connection, that is, the two people are friends with each other, then the two people are on the playing field. The probability of two strangers appearing at the same time is significantly higher than the probability of two strangers appearing at the same time. That is, through the athletes' "check-in" mental state data in the competition arena, people who frequently appear at the same place at the same time are discovered, that is, the relationship of friends.

The final co-occurrence matrix A obtained is a sparse matrix, and only the elements of the athlete's mental state data need to be stored during program processing. A is just a co-occurrence matrix, and the threshold T for judging the number of co-occurrences of friend relations needs to be determined. The threshold T is determined by the average number of co-occurrences of two people, that is, when the number of co-occurrences of two people exceeds the average, the two people are judged to be friends, namely:

$$Avg_i = \prod_{j=0}^{n-1} \frac{A_{ij}}{n-1} \quad i = 0,1,2,\ldots,n-1 \tag{1}$$

Avgi represents the average number of co-occurrences between the i-th person and other people, and n represents the total number of people.

$$T = \prod_{i=0}^{n-1} \frac{Avg_i}{n-1} \tag{2}$$

According to T, we calculate the friend relationship matrix F:

$$F_{ij} = \begin{cases} 0 & T > A_{ij} \\ 1 & T \le A_{ij} \end{cases} i,j = 0,1,2,\ldots,n-1 \tag{3}$$

The number of friends of the i-th person is:

$$F_i = \prod_{j=0}^{n-1} F_{ij} \tag{4}$$

In this way, the final social relationship feature, that is, the number of friends, is obtained. A greater number of friends indicates that the athlete is more socially active and has a relatively cheerful personality, and vice versa. The Pearson correlation coefficient is used to calculate the interpersonal relationship sensitivity score vector and the social relationship feature vector in the symptom self-rating scale. The result is 0.643, which proves that the social

relationship features obtained by this method are scientific.

## Interactive Multi-Model Fast Association Algorithm for Athletes' Mental State Data

### Multi-Model Algorithm

#### The First Generation of Multi-Model Algorithms

The first generation of multi-model (MM) algorithm uses a limited number of motion models to describe the athlete's motion state. There is no interaction between the motion models. They work in parallel based on their filters, and finally merge the results of the filters for output. Figure 1 shows the principal diagram of the first-generation multi-model algorithm. As the motion models and their filters are independent of each other, the first-generation multi-model (SMM) algorithm is also called the static multi-model (SMM) algorithm.

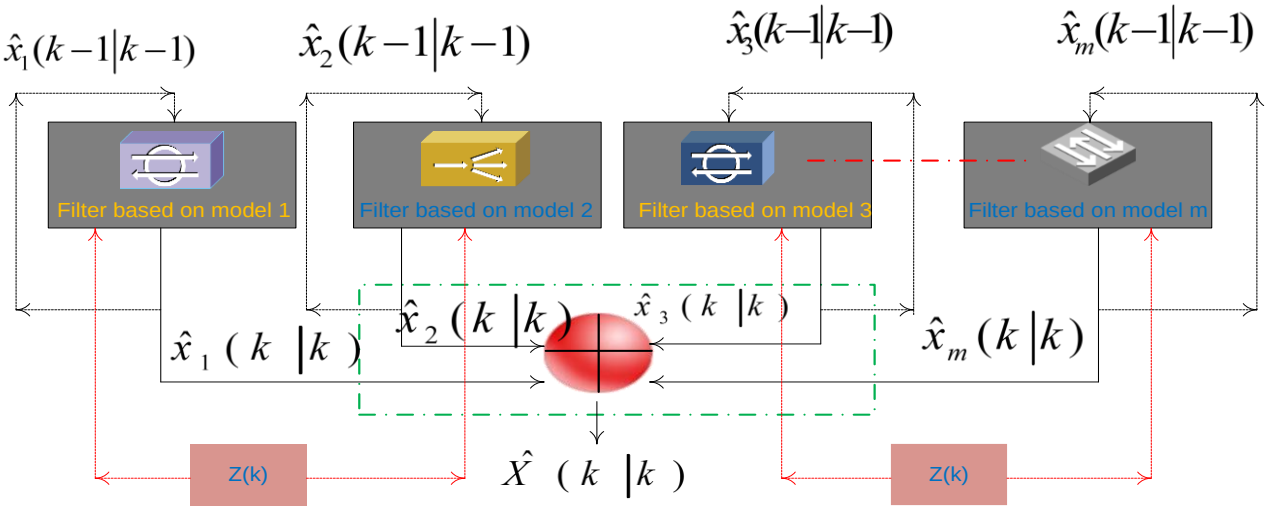


*Figure 1.* Block diagram of the first-generation multi-model algorithm

#### Interactive Multi-Model Algorithm

The first-generation multi-model algorithm is more suitable for uncertain systems. This is mainly because there is no interactive calculation between the models. Once the target athlete's mental state sports mode changes back and forth, it will cause large errors and greatly reduce the evaluation accuracy. In view of the shortcomings of the first-generation multi-model algorithm, the second-generation multi-model algorithm is developed. Among them, Interacting Multiple Model (IMM) is the most representative, which uses multiple sports models to describe the different sports states of the target athlete's mental state. Each model achieves smooth switching through Markov matrix and uses Kalman filter to estimate the mental state of the target athlete and update the model probability. Compared with the single-motion model, the interactive multi-model solves the problem of the mismatch between the motion state and the motion model when the maneuvering mode changes. It also overcomes the first-generation multi-model algorithm caused by frequent changes in the mental state of the target athlete.

Figure 2 illustrates a block diagram of the interactive multiple model (IMM) algorithm. The algorithm consists of four parts: inputting the state at the last moment for interactive operation, Kalman filtering, model probability update, and state estimation mixed output operation.

Suppose the discretized state equation of model Mj is:

$$X(k) = W_j(k-1) - X(k-1)\Phi_j(k|k-1) \quad (5)$$

The measurement equation is:

$$Z(k) = V_j(k-1) + X(k)H_j(k-1) \quad (6)$$

Assume that the prior probability of model Mj is:

$$\begin{cases} u_j(0) = P(M_j) \\ \sum_{j=0}^{r-1} u_j(0) = 1 \end{cases} \quad (7)$$

The Markov transition probability is:

$$\begin{cases} P\left[M_j(k) \mid M_i(k)\right] = p_{i/j} \\ \prod_{j=0}^{r-1} P_{i/j} = 1 \end{cases} \quad (8)$$

Based on the measurement data set Zk of athletes' mental state, the posterior probability of model Mj at time K is:

$$u_j(k) = P\left(M_{j-1} | Z^K\right) \quad (9)$$

#### Interactive Multi-Model Fast Association Algorithm for Athletes' Mental State Data

When calculating the optimal association probability, the joint probability athlete mental state data, the association algorithm needs to search for all possible target athlete mental state association solutions. The search process is equivalent to the problem of finding the number of combinations. When the target athlete's mental state and the number of mental states increase, it causes an exponential growth effect, therefore, it is difficult to apply in practice. The problems of the joint probability athlete's mental state data association algorithm also exist in the interactive multi-model joint probability athlete's mental state data association algorithm. The problem that needs to be solved is how to reduce the number of feasible matrices, the calculation complexity of the association probability, and the calculation amount of the algorithm, and in doing so, shorten the evaluation time of multiple athletes.

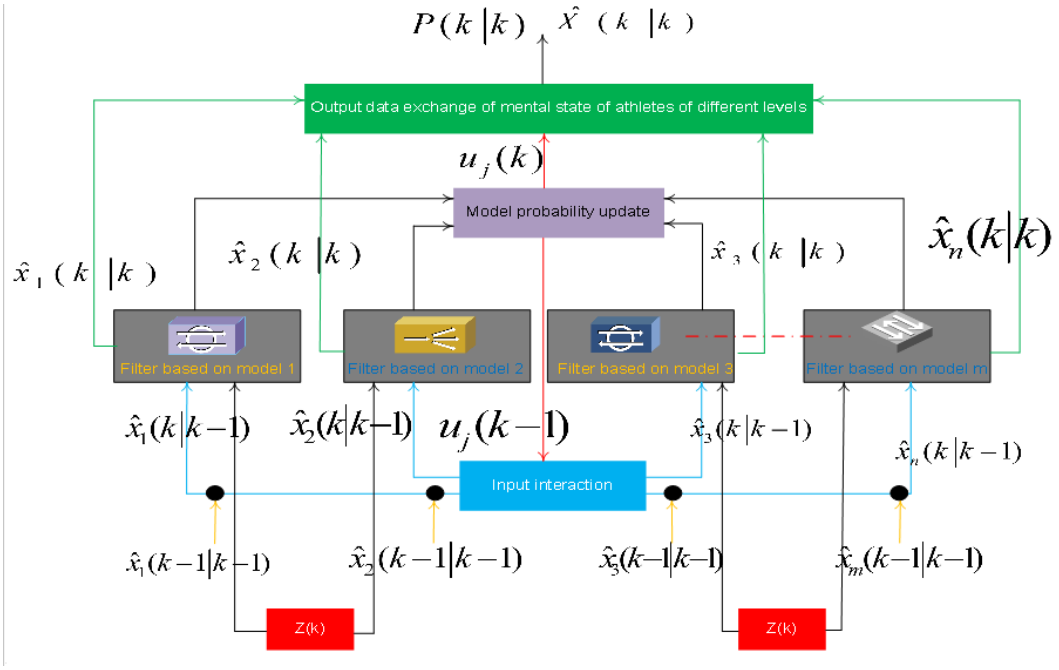


*Figure 2.* Block diagram of interactive multi-model algorithm

Athlete's mental state data fast association algorithm is based on the principle of probabilistic athlete's mental state data association algorithm, and the impact of the public mental state in the intersection area of multiple target athlete's mental state association gates is analyzed. The calculation of the algorithm is small, the calculation speed is fast, and the evaluation effect is not lost in the joint probability athlete's mental state data association algorithm. Considering the good performance of the fast association algorithm for athlete's mental state data, this paper uses the fast association algorithm for athlete's mental state data to replace the joint probability athlete's mental state data association algorithm and the interactive multi-model algorithm. A new algorithm for interactive multi-model algorithm is proposed. Model Athlete Mental State Data Fast Association Algorithm (IMM-FDA) solves the problem of too many possible joint events and excessive calculation in the interactive multi-model joint probability athlete mental state data association algorithm. The schematic diagram of the correlation analysis process of the mental states of different levels of athletes in the pre-match scene experiment is shown in Figure 3.

The interactive multi-model athlete mental state data fast association algorithm and the interactive multi-model algorithm have a similar structural system, including a set of filters corresponding to the different sports states of the target athlete's mental state. The switching of each sports model follows the state transition probability matrix, which is Marl. In the Kofu chain, the algorithm is also divided into four steps: input interaction, filtering, model probability update, and output synthesis. The difference lies in the filtering process, which uses the fast correlation algorithm of athletes' mental state data instead of Kalman filter. This study constructs a confirmation matrix to reflect the distribution of candidate mental states of each target athlete's mental state:

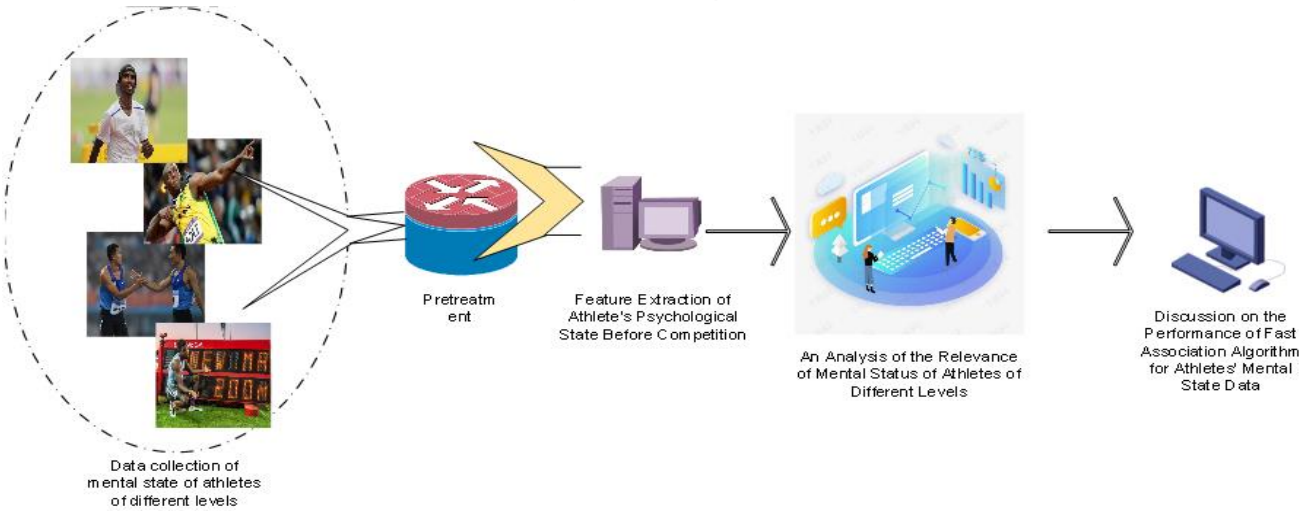


*Figure 3.* Schematic diagram of the correlation analysis process of different levels of athletes' mental states in the pre-match scene experiment

$$\Omega = [w_{jt}] = \begin{pmatrix} 1 & w_{11} & \cdots & w_{1n} \\ 1 & w_{21} & \cdots & w_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ 0 & w_{m1} & \cdots & w_{mn} \end{pmatrix} \begin{pmatrix} 0 \\ 1 \\ \vdots \\ m_k \end{pmatrix} \quad (10)$$

Among them, t=0, 1, N, n is the number of mental states of the target athlete, and m is the number of candidate mental states. Wjt=1 means that the mental state j=Yj may be derived from the target athlete's mental state t; wjt=0 means that the mental state Yj cannot be derived from the target athlete's mental state t. If t=0, it means that there is no target athlete's mental state.

The public mental state set Pub in the intersecting area of the association gate is:

$$Pub = \left[Y_j \middle| \prod_{t=0}^{N-1} w_{jt} \geq 1\right] \quad j = 0,1,2,\ldots,m-1 \quad (11)$$

For the mental state Yj in the set Pub, it is judged by the confirmation matrix whether it comes from the mental state of the target athlete:

$$T_j = \left[t \middle| w_{jt} = 0\right] \quad Y_j \rightarrow Pub \quad (12)$$

**The Improvement of The Rapid Association Algorithm for Interactive Multi-Model Athletes' Mental State Data**

**Expand The Associated Gate**

When the athlete evaluation algorithm selects effective measurement points for the filter, it needs to pass through the correlation gate to limit the area, and the prediction of the target athlete's mental state determines where the correlation gate is located. Due to the lag in the estimation of the target athlete's mental state, the evaluation system uses the past target athlete's mental state when making predictions. At this time, the target athlete's mental state may have changed, and the delay in time can easily lead to the target athlete's loss of psychological state. Therefore, in order to achieve an accurate assessment of athletes, it is necessary to ensure that the mental state of the target athletes obtained is measured accurately. The relevance gate can not only limit the number of impossible decisions to a certain range, but is also a prerequisite for maintaining the athlete's assessment or updating the mental state track of the target athlete. The number of candidate measurements depends on the size of the correlation gate. If the volume is too large, there will be many candidate measurements, but the clutter entering the system will increase. The decrease in evaluation accuracy will also increase the consumption of system resources; and the volume of the correlation gate will be too small. Although it limits the amount of clutter, it also reduces the probability of detecting the correct measurement.

The IMM-FDA algorithm uses an elliptical association gate. In order to solve the problem of athletes losing track, this article introduces an expanded association gate in the IMM-FDA algorithm. Once the target athlete's mental state changes, the innovation process no longer conforms to the elliptical gate. Gaussian hypothesis is that when the detection probability of athletes is reduced, and the effective measurement exceeds the detection range of the correlation gate, the correlation gate gradually expands and the effective measurement is re-detected to reduce the loss rate of the athlete's assessment.

The elliptical association gate used in the IMM-FDA algorithm is as follows:

$$z_m(k-1)^T - S^{-1}(k) \bullet z_m(k) \bullet z_m(k-1) \leq G \quad (13)$$

Among them, zm(k) is the actual measurement at time k, S(k) is the innovation covariance matrix at time k, and G can be determined by itself according to the actual situation.

As the system has a certain lag in the estimation of the target athlete's mental state, when the target athlete's mental state is strongly maneuvered and is out of the detection range of the associated gate, the effective measurement will not be detected, which will lead to system update errors. In order to solve the problem of the target athlete's mental state losing follow-up, the association gate can be expanded to increase the probability of the target athlete's mental state being re-detected and reduce the rate of losing follow-up. If the correlation gate is too large or too small, it is not conducive to the accurate evaluation of the athletes. Therefore, the proper expansion ratio is particularly important for the correlation gate. This study pre-sets a set of athletes' mental state data, when the system fails to detect a valid measurement, the method of gradually expanding the correlation gate is adopted, and the optimal expansion ratio is selected. The specific process of using the expanded association gate is shown in Figure 4.

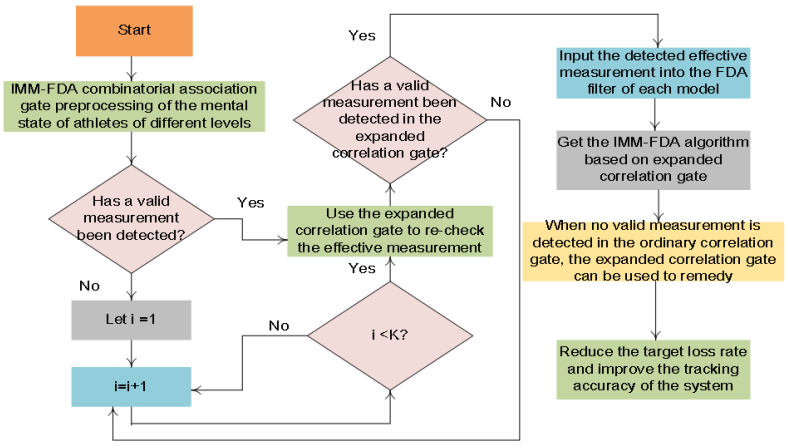


*Figure 4.* The specific process of using the expanded association door

### Adaptive Sampling Period

After the IMM-FDA algorithm adopts the expanded correlation gate, even though the determination accuracy of the athlete's mental state and the rate of follow-up significantly improve, the improved new algorithm needs to adjust the size of the correlation gate in a timely manner according to the number of effective detection points. Increasing the computational complexity of the algorithm goes against the original intention of the algorithm. Therefore, under the premise of ensuring the accuracy of the athlete's mental state determination, an adaptive sampling period strategy is adopted. When the athlete's mental state determination accuracy is relatively high, a larger sampling period is used to reduce the sampling frequency and reduce the amount of algorithm calculations. When the athlete's mental state changes to the original maneuvering state and the evaluation accuracy becomes low, the sampling period is reduced and the sampling frequency is increased to balance the judgment accuracy of the athlete's mental state and the calculation amount of the algorithm.

The judgment accuracy of the athlete's mental state is reflected by the evaluation state covariance matrix, and the sampling period at the next moment can also be determined by the evaluation state covariance matrix. At the next moment, the predictive evaluation error covariance matrix is an increasing function of the sampling period T, and the evaluation error will increase with the increase of the sampling period. The predictive covariance threshold method selects the maximum value of the sampling period when the evaluation accuracy requirements can be met. Only when the target athlete's mental state prediction error covariance no longer meets the set threshold, the next sampling is performed. The prediction covariance threshold formula is as follows:

$$max[T_i] \quad st. \quad P_{TH}(t_k) > P(t_{k-1}) \tag{14}$$

Among them, PTH is the upper limit of the prediction covariance matrix.

## Relevance Research Results and Analysis

### Investigation and Analysis of Pre-Match Self-Confidence of Athletes of Different Levels

From the survey, the self-confidence subscale can be divided into two categories, namely confidence in the game and confidence in athletes. The mental state data of these athletes shows that the athletes are well-prepared before the game, including physical and psychological. The options for athletes' self-confidence also reflect the athletes' good state before the game. This shows that the athletes are in a good or positive state of mind pre-match. It is found that 31% of athletes think that being in a good mood before the game and feeling relaxed is the performance of a good arousal level before the game, which may be mainly due to the athlete's individual personality characteristics. Figure 5 shows the pre-match self-confidence of athletes of different levels.

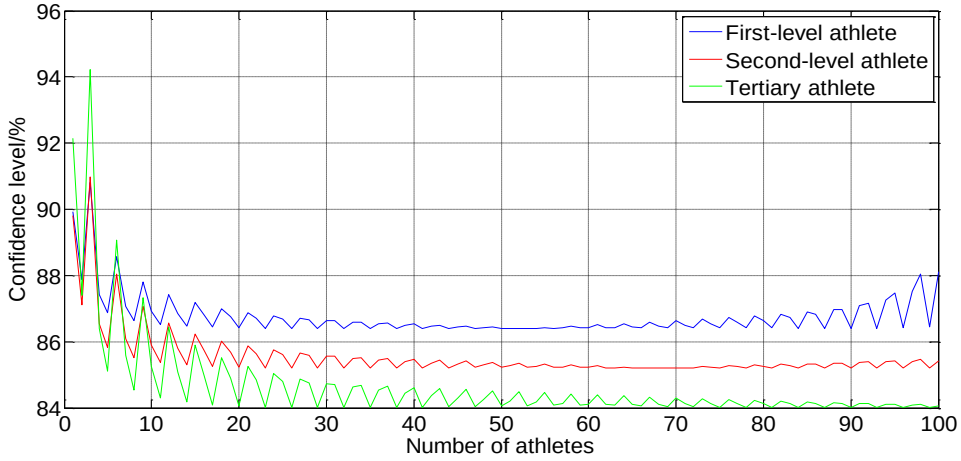


*Figure 5.* Pre-match self-confidence of athletes of different levels

### Investigation and Analysis of Individual Failure Anxiety of Athletes of Different Levels Before the Competition

The individual failure anxiety of athletes is mainly divided into self-directed and external-directed. While athletes recognize individual sports skills, volleyball is a collective competition event. The ability of one or a few outstanding athletes alone cannot win the game. It requires team cooperation and the rational use of skills and tactics. There are also some athletes who care more about the coach's opinion of themselves. The above is the influence of externally directed conditions on individual failure anxiety. The other is the self-directed type of athletes. This shows that athletes can focus on the game before the game. The specific performance of the focus is to exclude things that are not related to the game and focus on their skills, movements, and the dynamics of the game. Figure 6 shows the individual failure anxiety of athletes of different levels before the competition.

### Investigation and Analysis of Social Expectation Anxiety of Athletes of Different Levels Before the Competition

As the leader of the entire team, the coach is well-aware of the technical and tactical level of the athletes, so the

athletes value the coach's views. Volleyball is a sport that requires team coordination, so the cooperation between teammates is particularly important. In the questions "I'm worried about what my teammates will think and say" and "I'm worried about letting my teammates down", 48% and 51% of athletes chose "always". The opinions and opinions of friends also have a certain impact on athletes. Social expectation anxiety may become an important reason for athletes' pre-match anxiety, which may, arguably, be due to the influence of Chinese collectivist culture. Figure 7 shows the social expectation anxiety of athletes of different levels before the game.

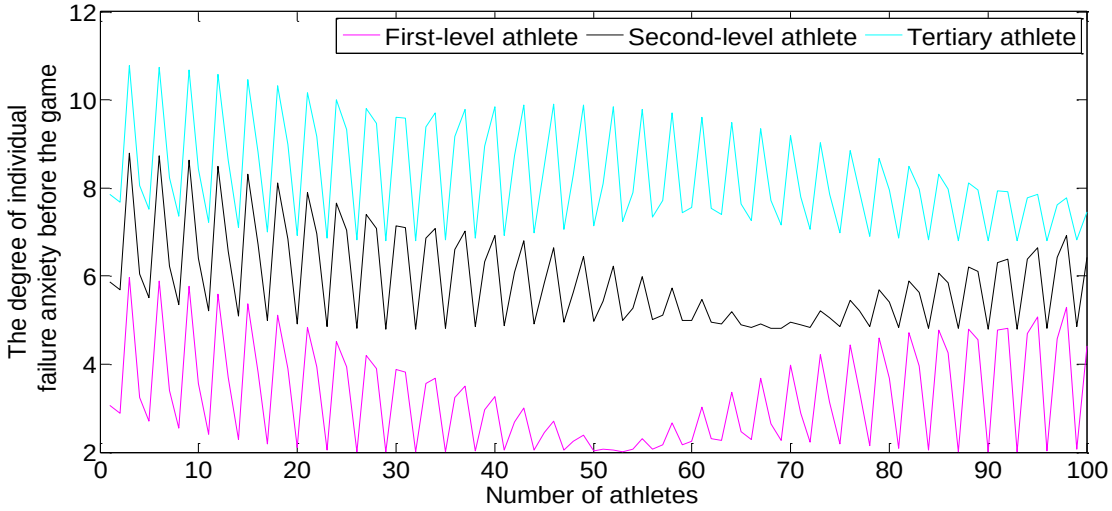


*Figure 6.* Individual failure anxiety of athletes of different levels before the competition

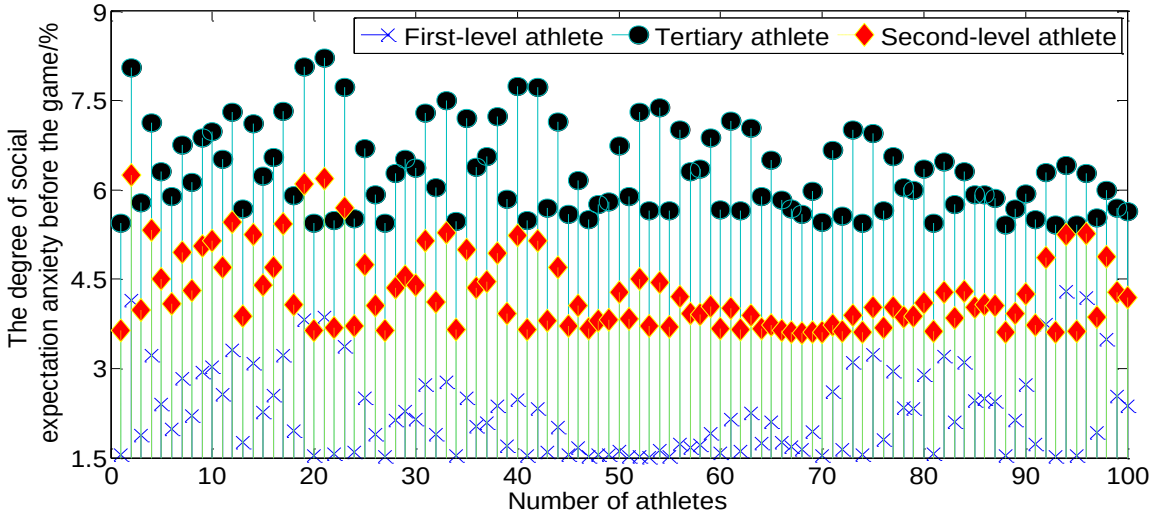


Figure 7. The social expectation anxiety of athletes of different levels before the competition

**Investigation and Analysis of Pre-Match Physical Anxiety of Athletes of Different Levels**

Physical anxiety is a manifestation of anxiety caused by the mind, and is reflected through physiological characteristics. By investigating the physical anxiety of 10 athletes in the Inner Mongolia Autonomous Region, it can be concluded from the questions "I feel muscle stiffness", "My hands are wet and cold" and "My heartbeat is very strong". Most athletes do not show physical anxiety. However, some athletes still have specific manifestations of varying degrees of physical
anxiety. This may be due to the lack of opportunities for athletes to participate in large-scale events as well as other factors such as athletes' own competitive ability, venue and surrounding environment. Athletes'physical condition is the key factor for victory in the competition, and a good psychological state before the game is the basis for ensuring that athletes will not have physical anxiety. It can be evidently seen that a good pre-match mental state is an important guarantee for athletes to create good results. Figure 8 shows the degree of physical anxiety of athletes of different levels before the competition.

**Analysis of the Psychological Factors of the Top Three Athletes of the National Sports Team Before the Game**

From the survey in Figure 9, the average score on the self-confidence subscale of the 10 athletes of the first sports team is 27.3, which is the highest among all colleges and universities. The higher the score, the stronger the self-confidence, indicating that the team players have high self-

confidence. There is no significant difference between the average scores of the 2nd and 3rd national sports team, which are 23.6 and 25.7 respectively. In the individual failure anxiety subscale, the average scores of the top three are 14.5, 20.4, and 17.8, respectively. In the physical anxiety subscale, the average score of the first sports representative team is also lower than the other two representative teams, and the degree of physical anxiety is the lowest. On the whole, the pre-match mental state of the athletes of the first national sports team shows characteristics of high self-confidence, low individual failure anxiety, low physical anxiety, and low social expectation anxiety. This characteristic is in line with the mental state of an excellent volleyball team before the game and helps enhance the level of arousal of ideal emotions before the game.

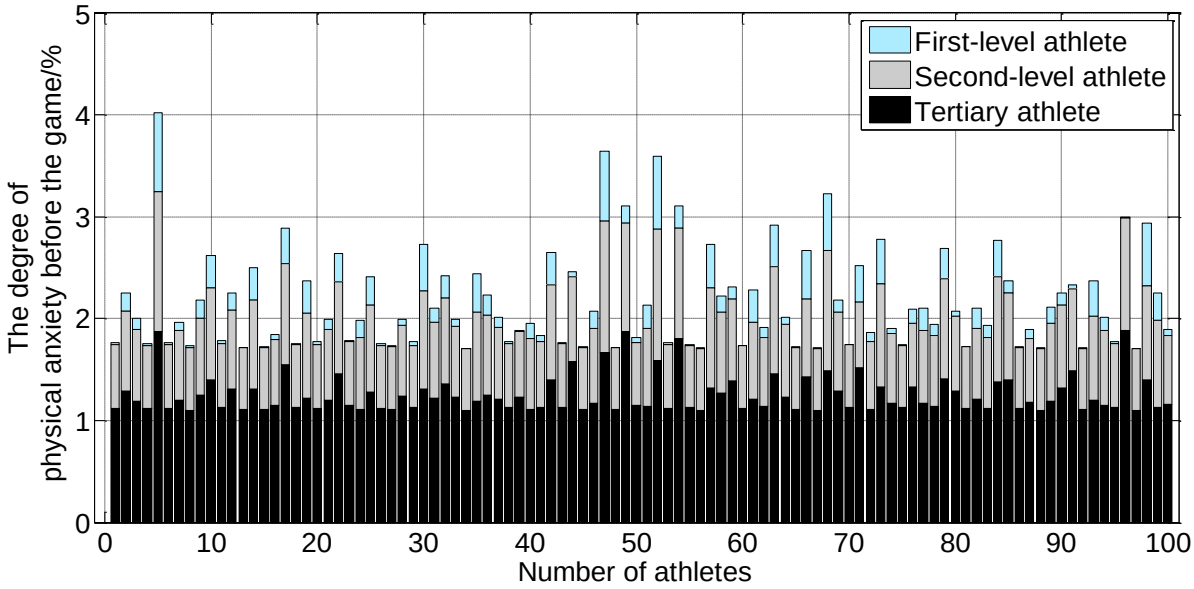


*Figure 8.* The degree of physical anxiety of athletes of different levels before the competition

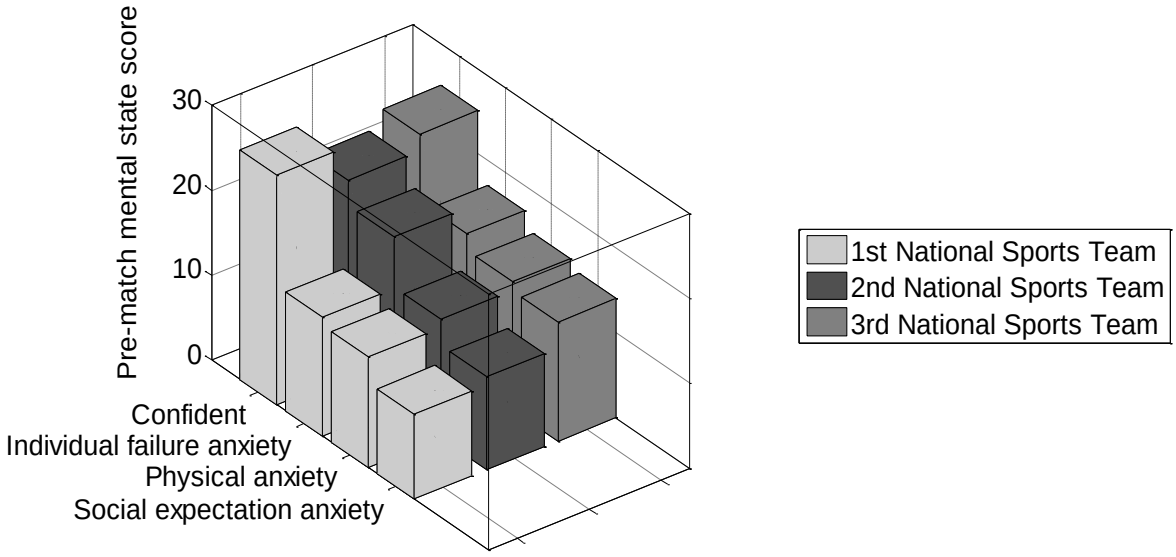


*Figure 9.* Pre-match mental state scores of the top three sports teams

**Analysis of Psychological Factors Before the Fourth to Sixth Place Teams**

From the survey in Figure 10, the fourth sports team shows higher self-confidence from the self-confidence subscale. The score of the individual failure anxiety subscale is basically the same as the overall average, and the score of the physical anxiety subscale was 17.6 slightly higher. On the overall average, the average score for social expectation anxiety is 15.5. Judging from the mental state data of the athletes of the sixth national sports team, the score of the self-confidence subscale is slightly lower than that of other teams, and the average score of individual failure anxiety is higher than that of other colleges and universities, with a score of 25.9. Among the teams surveyed ranked sixth, individuals have a higher degree of anxiety about failure. The average scores of the two subscales of physical anxiety and social expectation anxiety are also higher than the overall average. The scores of each subscale of the fifth national sports team are at the middle level of all men's volleyball teams surveyed.

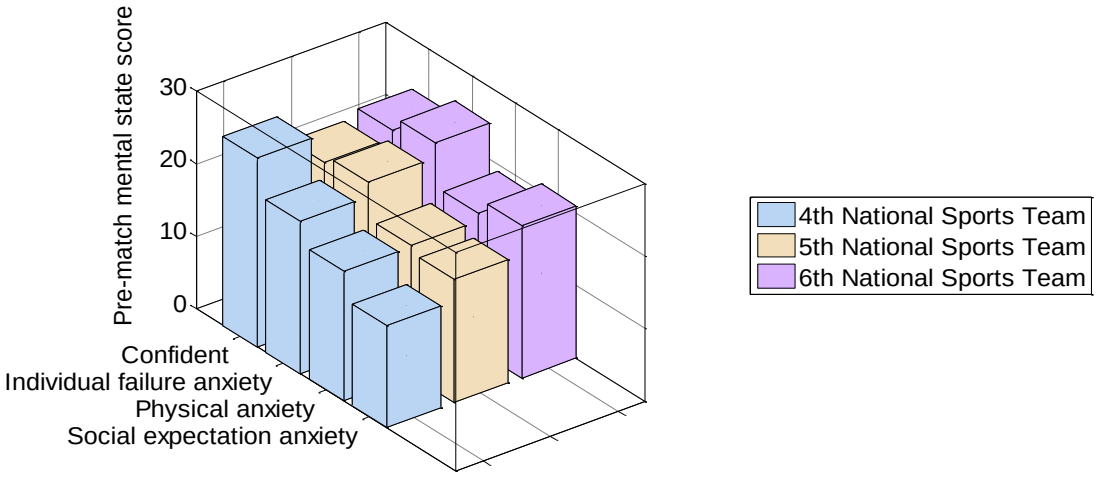


*Figure 10.* Pre-match mental state scores of four to six sports teams

## Conclusion

The distribution of athletes' mental state data on the Athlete Scale, as well as the connection between the measurement dimensions, are thoroughly examined in this paper, which confirms the strong link between depression and the risk of suicide and other mental states. The qualities linked to the athlete's mental state are described in this article from two perspectives: static characteristics that do not vary substantially over time and dynamic characteristics that fluctuate continuously over time. Individuals' inherent psychology and personality are represented by these two elements of traits. Single-factor binary logistic regression, multi-factor binary logistic regression, and multiple linear regression are used to analyse static characteristics, which include some basic attributes of athletes. Attributes related to depression are analysed using single-factor binary logistic regression, multi-factor binary logistic regression, and multiple linear regression. The interactive multi-model joint probability athlete's mental state data association algorithm is combined effectively with the fast association algorithm of athlete's mental state data, and the Monte Carlo simulation comparison is carried out with the interactive multi-model joint probability athlete's mental state data association algorithm. The latter is compared to the evaluation error curve produced via simulation. The interactive multi-model athlete mental state data fast correlation algorithm has a small amount of calculation, but its evaluation performance is comparable to that of the interactive multi-model joint probability athlete mental state data correlation algorithm, demonstrating the new algorithm's feasibility. The extended association gate technique is used to minimise the target athlete's mental state loss by addressing the issue of the algorithm's lack of follow-up to the target athlete's mental state. An adaptive sample period method is used to balance the algorithm's assessment accuracy and the quantity of computation in order to minimise the evaluation system's resource consumption. Each athlete representative team's self-confidence is usually greater, and they are essentially above average. Only a few teams have failed to achieve the average degree of self-assurance. The men's and women's volleyball teams have identical rosters. The top three teams had lower individual failure anxiety than the general average, whereas other athlete teams have greater individual failure anxiety. The top three teams had lower levels of physical anxiety than the general average, and their levels of physical anxiety are not excessive. The fourth through sixth positions are all above normal, and bodily anxiety is considerable. The most significant impediment to high-level athletes achieving an optimal pre-match condition is their worry about societal expectations.

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