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Diversified Modeling of College Sports Athletics Data and Its Optimization Based on Computational Methods

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ABSTRACT
The article explores the method of diversified modeling of college sports track and field data, aiming to provide a basis for scientific training of college sports track and field. In this article, the diversified modeling of college sports track and field data is carried out by using multiple linear regression model, testing method and mathematical statistics method in order to analyze the sports characteristics and training needs of college track and field athletes. Using multiple linear regression model to analyze the influencing factors of track and field special movement patterns, then, on the basis of clarifying the training needs of track and field special movement patterns, combining the theoretical study of functional movement screening with the actual practice of track and field sports, carrying out the FMS test of the research object, and proposing the optimization plan of college sports track and field training after analyzing the results of functional movement screening of different track and field events. By using the multi-dimensional modeling method of college sports track and field data proposed in this paper to analyze the influencing factors of athletes' track and field special action patterns, it is found that there is a significant medium correlation between the "torso forward swing and hip and knee rotation speed" in the buffer action link and the "torso extension speed" in the kick and stretch action link and the in-situ jump height. At the same time, there was a significant correlation between the common factor "trunk forward swing and hip and knee rotation speed" and the "trunk extension speed" in the push and extension link.

Keywords: multiple linear regression model, FMS test, mathematical statistics, track and field data

1. Introduction

In college sports, track and field has always occupied an important position. Athletics includes a variety of basic sports such as race walking, running, high jump, long jump, throwing, etc., which requires that track and field athletes must have strong endurance, explosive force, willpower and other

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qualities [1]. From the professional point of view of sports analysis, scientific and reasonable track and field can promote the human body nerves, muscles, internal organs and other organs of the full range of activities, is the basis of various sports programs, but also known as "the king of sports programs", can be in the ultra-low-cost, ultra-low restriction of the environment, the comprehensive and effective development of physical fitness and motor skills, and to promote other sports programs. The development of physical fitness and motor skills in a low-cost, ultra-low-limit environment, but also to promote the development of other sports programs plays a vital role [2-4].

At the same time, it can also shape the will character of students to bear hardships and stand hard work, actively enterprising, overcoming difficulties, and cultivate the resistance to setbacks, the ability to fight and the spirit of teamwork, which has a relatively unique charm in various sports [5]. However, with the development of the times and the continuous updating of the concept of education, the traditional college track and field training mode faces many challenges. First, students' interest in track and field gradually declined. Secondly, the lack of scientific training programs and the obsolescence of training methods constrain the effect of college athletics. College sports track and field training is highly dependent on coaching experience, and almost all of them are unified training programs, ignoring the physical condition, psychological quality, gender and other aspects of the students, accompanied by the aging of training equipment and other problems [6-8]. This not only leads to the students' low motivation for sports, but also the high intensity sports training will make the weaker students suffer certain injuries.

With the development of modern science and technology, physical education has also gradually introduced some intelligent equipment and scientific methods for track and field training, which not only stimulates students' interest, but also promotes scientific track and field sports [9-10]. In these devices and methods track and field data occupies an important position, which is the necessary basis for realizing the high-quality training effect of students. In the process of athletics, real-time changes in students' physiological conditions, psychological parameters, and movement trajectories, as well as different movement techniques, exercise intensity and duration, track types, and training programs, lead to a multidimensional and dynamic form of track and field data, and the data interact with each other. Diversified modeling of track and field data can help coaches and students better understand the training process and results, identify potential problems and formulate appropriate plans to improve training effectiveness and athletic performance.

The study firstly clarified the research object and research purpose, and elaborated on the research methods related to multiple linear regression model, mathematical statistics method and measurement method, and designed a method for diversified modeling of college sports track and field data. Subsequently, the data of track and field athletes from a university were analyzed to explore the kinematic influencing factors and muscle activation intensity characteristics of the special action patterns using multiple linear regression analysis, in order to clarify the kinematic factors affecting the special jumping height, throwing and moving speed. The activation intensity of each muscle group in different action segments of the specialized movement pattern was also compared and analyzed to clarify the training needs of the specialized movement pattern. Then the results of the functional movement screening of different track and field events were analyzed for the research subjects, and finally the test results were used as a benchmark to propose an optimization plan for track and field training in collegiate sports.

2. Overview

Diversified modeling of track and field data involves data collection, preprocessing, and constructing models, etc. Li and Li [11] developed a track and field training information collection and feedback system through the weight coefficients fusion method, D-S evidence theory algorithm, and Kalman filtering algorithm, which consists of multiple sensors for information collection, and to a certain extent assisted in the improvement of athletes' performance. Differently, Wu and Wen [12] constructed a training information collection and feedback system that can monitor track and field athletes relying on wireless medical sensor networks, while incorporating an embedded real-time system to collect and store track and field data, which elevated the accuracy of information collection by 8.6%.Han [13] constructed a track and field athlete behavioral data collection and analysis system, which uses wearable sensor modules for data collection and can realize real-time behavioral data collection. While Tang et al [14] used SAC (Soft Actor-Critic) optimized deep learning embedded in the IoT framework to capture and transmit track and field sports in real time, and then edge computing for instant analysis and response constitutes the whole system, which improves the data in terms of accuracy and the efficiency of analysis and response as compared to the traditional collection system.Lin et al [15] suggested that in the context of big data, the collection, processing, and analysis of big data-related behaviors of athletics performed with machine learning-supported ATI (Account Takeover Insights) model are more accurate and stable.

3. Diversified Modeling of Athletic Data in Higher Education Sports

In this paper, 20 track and field athletes from a university were studied and experimented to screen and assess FMS functional movements, and the experiment utilized multiple linear regression analysis, mathematical statistics, and measurement methods. Specifically, the multiple linear regression method was applied to analyze the influencing factors of track and field-specific movement patterns. In the measurement method, according to the testing process and testing standards of the FMS test, the professional testers completed the test on the track and field athletes and scored the quality of their completed movements accordingly. SPSS software is used to summarize, organize and analyze the raw data of the Functional Movement Screening Test to provide a scientific basis for the analysis of the paper. Finally, according to the experimental results to optimize the college sports track and field training program.

3.1. Principles and calculations of multiple linear regression models

In order to explore the influencing factors of special sports movement patterns in college sports athletics, the article proposes to use multiple linear regression model to carry out the relevant regression study, which provides data reference for the scientific training of college sports athletics.

3.1.1. Classical multiple linear regression models. Assume that there is a dependent variable Y linearly related to the independent variable $x_1, x_2, \ldots, x_m$. $(y_t, x_{t1}, x_{t2}, \ldots, x_{tm})(t=1,2,\ldots,n)$ is the n sets of data obtained from the collection and they satisfy the following regression model:

$$\begin{cases} y_t = \beta_0 + \beta_1 x_{t1} + \ldots + \beta_m x_{tm} + \varepsilon_i (t=1,2,\ldots,n), \\ E(\varepsilon_t)=0, Var(\varepsilon_t)=\sigma^2, Cov(\varepsilon_i,\varepsilon_j)=0 (i \neq j) \\ \text{or } \varepsilon_t \sim N(0,\sigma^2), \text{Mutually independent}(t=1,2,\ldots,n). \end{cases} \tag{1}$$

$$C = \begin{bmatrix} 1 & x_{11} & x_{12} & \cdots & x_{1m} \\ 1 & x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ 1 & x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} = (1_n \mid X)$$
$$Y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}, \beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_m \end{bmatrix}, \varepsilon = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix} \tag{2}$$

The matrix form of the regression model is then:

$$\begin{cases} Y = C\beta + \varepsilon \\ E(\varepsilon) = 0_n, D(\varepsilon) = \sigma^2 I_n \end{cases} \tag{3}$$

Or:

$$\begin{cases} Y = C\beta + \varepsilon \\ \varepsilon \sim N_n(0, \sigma^2 I_n) \end{cases} \tag{4}$$

Call the model a classical multiple linear regression model. In the classical multiple linear regression analysis model, Y is an observable random vector while ε is an unobservable random vector, C is a known matrix, β, σ^2 is an unknown parameter, and let $n > m$, and $rank(C) = m+1$ [16]. In the classical multiple linear regression analysis problem, we focus on the estimation and testing of parameters $\beta = (\beta_0, \beta_1, \ldots, \beta_m)'$ and σ^2 in the model.

3.1.2. Estimates:

1) Least squares estimation of parameter vector β. In a classical multiple linear regression model, the least squares estimator $b = (b_0, b_1, \ldots, b_m)'$ of parameter β should minimize the sum of error squares $Q(b)$, i.e.:

$$Q(b) = \min_{\beta} Q(\beta) \tag{5}$$

Among them:

$$\begin{aligned} Q(\beta) &= \sum_{t=1}^{n} \varepsilon_t^2 = \sum_{t=1}^{n} \left[y_t - (\beta_0 + \beta_1 x_{t1} + \ldots + \beta_m x_{tm}) \right]^2 \\ &= (Y - C\beta)'(Y - C\beta) \end{aligned} \tag{6}$$

Let $raink(c) = m+1 \le n$, then $\hat{\beta} = b = (C'C)^{-1} C'Y$ is the least squares estimate of parameter β.

The least squares estimate $\hat{\beta} = b$ of the parameter vector β is exactly the solution of a system of linear equations of order $m+1$. We often refer to the above system of equations as regular equations.

$$C'C\beta = C'Y \tag{7}$$

2) Statistical properties of least squares estimation. Property 1 b is a linear unbiased estimator of the minimum variance of β.

Property 2 $b \sim N_{m+1}(\beta, \sigma^2 (C'C)^{-1})$.

Property 3 Under the assumption of $\varepsilon \sim N_n(0, \sigma^2 I_n)$, b is still the estimate with the smallest variance of all unbiased estimates.

3) The estimate of σ^2. The maximum likelihood estimate of parameter σ^2 is easily obtained using the principle of great likelihood ratio:

$$\begin{aligned} \hat{\sigma}^2 &= \frac{1}{n} \sum_{i=1}^{n} \left[y_i - (b_0 + b_1 x_{i1} + \ldots + b_m x_{im}) \right]^2 \\ &= \frac{1}{n} (Y - Cb)'(Y - Cb) \\ &= \frac{1}{n} Q(b) \end{aligned} \tag{8}$$

But since $\hat{\sigma}^2$ is not an unbiased estimator of σ^2, we usually take:

$$s^2 = \frac{1}{n-m-1} Q(b) \tag{9}$$

As an estimator of σ^2, it is an unbiased estimator of σ^2.

4) Estimation of parametric function $\alpha`\beta$. In classical multiple linear regression analysis, finding the least squares estimate b of parameter β is not our ultimate goal. Our aim is to estimate Y, and Y is a linear function of $x_1, x_2, \ldots, x_m$:

$$Y = \beta_0 + \beta_1 x_1 + \ldots + \beta_m x_m = (1, x_1, \ldots, x_m)\beta = \alpha'\beta \tag{10}$$

i.e., estimate $\alpha'\beta$ as a linear function of the parameter vector β.

Since b is the maximum likelihood estimator of β, $a'b$ is also the maximum likelihood estimator of $\alpha'\beta$, so we use $a'b$ as the estimate of $\alpha'\beta$. It has all the goodness of the maximum likelihood estimator. Therefore, $a'b$ is the minimum variance linear unbiased estimator of $\alpha'\beta$ [17].

3.1.3. Testing:

1) Square sum decomposition formula. For any given array of observations:

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \cdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} \tag{11}$$

Constant has the formula:

$$\sum_{i=1}^{n}(y_i - \overline{y})^2 = \sum_{i=1}^{n}(y_i - \hat{y}_i)^2 + \sum_{i=1}^{n}(\hat{y}_i - \overline{y})^2 \tag{12}$$

Among them:

$$\overline{y} = \frac{1}{n}\sum_{i=1}^{n} y_i \tag{13}$$

$$\hat{y}_i = \hat{\beta}_0 + \hat{\beta}_1 x_{i1} + \hat{\beta}_2 x_{i2} + \ldots + \hat{\beta}_m x_{im} (i = 1, 2, \ldots, n) \tag{14}$$

and the least squares estimate of β is $\hat{\beta} = (C'C)^{-1}C'Y$. We call the formula the sum-of-squares decomposition formula.

In the sum-of-squares decomposition formula, the left $\sum_{i=1}^{n}(y_i - \overline{y})^2$ of the equal sign embodies the total magnitude of fluctuations in Y the observations $y_1, y_2, \ldots, y_n$ and is called the total sum of squared deviations, denoted l'_{yy} (or TSS). The second term to the right of the equal sign in the sum-of-squares decomposition formula $\sum_{i=1}^{n}(\hat{y}_i - \overline{y})^2$ embodies the magnitude of the fluctuations in the n estimates $\hat{y}_1, \hat{y}_2, \ldots, \hat{y}$ that are due to the fact that there is indeed a linear relationship between Y and the independent variable $x_1, x_2, \ldots, x_m$ and through the change in $x_1, x_2, \ldots, x_m$ it, and is therefore called the regression sum-of-squares, denoted U (or MSS). The first term $\sum_{i=1}^{n}(y_i - \hat{y}_i)^2 = \sum_{i=1}^{n}\hat{\varepsilon}_i^2$ to the right of the equal sign is referred to as the residual sum of squares or residual sum of squares, denoted Q (or ESS). Under the assumptions of the classical multiple linear regression model, i.e:

$$E(Y) = \beta_0 + \beta_1 x_1 + \ldots + \beta_m x_m \tag{15}$$

Q is due to random errors. Using the above notation, Eq. can then be abbreviated as: $l_{yy} = Q + U$ or TSS = ESS + MSS.

2) Significance test of regression equation. The test of significance for the regression equation is to test whether the following hypotheses are valid:

$$H_0 : \beta_1 = \beta_2 = \ldots = \beta_m = 0 \tag{16}$$

From the meaning of MSS and ESS and the sum-of-squares decomposition formula, the statistics for testing the hypotheses can be constructed using the ratio MSS/ESS.

In the classical multiple linear regression model, under:

(1) $\hat{\beta} - N_{m+1}(\beta, \sigma^2 (C'C)^{-1})$.

(2) $\frac{1}{\sigma^2} Q - \chi^2_{n-m-1}$.

(3) $\hat{\beta}$ and Q are independent of each other.

(4) When $H_0 : \beta_1 = \beta_2 = \ldots = \beta_m = 0$ holds, $\frac{U}{\sigma^2} = \frac{MSS}{\sigma^2} \sim \chi^2_m$

Using the above theorem, to test H_0, we can construct the following test statistic:

$$F = \frac{U / m \cdots}{Q / (n-m-1)} = \frac{MSS / m}{ESS / (n-m-1)} = \frac{MMS(\text{Model mean square})}{MSE(Mean\ square\ error)} \tag{17}$$

The test statistic $F \sim F(m, n-m-1)$ when H_0 holds, where m is called the degrees of freedom of the model and $n-m-1$ is called the degrees of freedom of the error.

Using n sets of observations, the probability of significance (p value) and the value of the test statistic F (denoted as f_0) are calculated. In this case, the probability of significance p value is the probability of F being greater than or equal to f_0 under H_0, using the distribution pattern of the test statistic F. If the resulting p value is small, then based on probability statistics ideas, small probability events do not generally occur in a practice, such as if small probability events occur, will negate the premise assumption H_0. Otherwise H_0 compatible.

3) Significance test of regression coefficients. A significance test of the regression equation, if H_0 is rejected, it only means that $\beta_1, \beta_2, \ldots, \beta_m$ is not all 0, but it does not exclude that some β_i is 0. If $\beta_i = 0$, it means that the effect of the independent variable x_i on the dependent variable Y is not significant, and it should be excluded from the regression model. It is therefore essential to conduct a case-by-case test of whether the regression coefficients $\beta_i (i = 1, 2, \ldots, m)$ are 0 or not. That is, test the following hypotheses:

$$H_0^{(i)} : \beta_i = 0 (i = 1, 2, \ldots, m) \tag{18}$$

In order to construct a test statistic to test the above hypothesis, the concept of partial regression sum of squares is introduced here. It is a statistic that characterizes the magnitude of the effect of a particular independent variable on Y.

Let U be the sum of squares of the regression of $x_1, \ldots, x_m$ on Y. $U(i)$ is the sum of squares of the regression of the remaining $m-1$ independent variables on Y after removing x_i. Then $P_i = U - U(i)$ (or $P_i = Q(i) - Q$) is said to be the partial regression sum of squares of the variables.

$P_i = \hat{\beta}_i^2 / l^n (i = 1, 2, \ldots, m)$ is the formula for P_i, where l^{ni} is the ith diagonal square element of L^{-1}, and $L = \overline{X}' \overline{X}$, $\overline{X}$ are the data arrays obtained by centering. P_i denotes the value of the decrease in the regression sum of squares (MSS) (or increase in the residual sum of squares (ESS)) after removing the independent variable x_i. By definition, a large value of P_i means that x_i is important, and a small value means that x_i is not important.

The test statistic for test $H_0 : \beta_i = 0(i = 1,2,\ldots,m)$ is optional:

$$F_i = \frac{P_i}{Q/(n-m-1)} \tag{19}$$

Or:

$$t_i = \frac{\hat{\beta}_i / \sqrt{l^{ii}}}{\sqrt{Q/(n-m-1)}} \tag{20}$$

By his own knowledge, he can be obtained:

$$\hat{\beta}_i \sim N(\beta_i, \sigma^2 l^{ii}) \tag{21}$$

When $H_0^{(i)}$ holds, $\frac{\hat{\beta}_i}{\sigma l^{ii}} - N(0,1)$, that is, $\frac{\hat{\beta}_i^2}{\sigma^2 l^{ii}} - \chi^2(1)$. And is independent of Q, so that

$$F_i = \frac{P_i}{Q/(n-m-1)} \sim F(1, n-m-1) \tag{22}$$

$$t_i = \frac{\hat{\beta}_i / \sqrt{l^{ii}}}{\sqrt{Q/(n-m-1)}} \sim t(n-m-1) \tag{23}$$

Given the significance level α, the values of the test statistic (denoted as f_i) and Q, P_i are computed from the sample observations and the probability of significance value (p value) is computed: $p = P\{F_i \ge f_i\}$. If $p < \alpha$, H_0 is negated, i.e., it is considered that the effect of x_i on Y is significant (x_i is significant in the regression equation). Otherwise H_0 compatible.

4) Establishing the "optimal" regression equation. The "optimal" regression equation is the one that includes only the variables that are significant for Y at significance level α and excludes the variables that are not significant for Y at significance level α.

After testing each of the m variables, if all m variables are significant at a given level of significance α for Y, the resulting equation is considered the "optimal" regression equation. If there are insignificant variables, only one can be removed at a time, and then the remaining variables are regressed against Y each other, and then tested one by one, with only one of the least significant variables allowed to be removed at a time. Repeat the above steps until every variable in the equation is significant. The resulting equation is the "optimal" regression equation. This equation can be used to forecast or control the response variables in the model.

3.2. Mathematical and statistical methods

Athletic test scores of college students were tested and analyzed using EXCEL and SPSS software. Kolmogorov-Smirnov was used to test whether the data obeyed normal distribution. If the data obeyed normal distribution, one-way ANOVA was used to compare the difference in test scores between injured and uninjured, otherwise Kruskal-Wallis H test was used. If the data obeyed normal distribution, the independent samples t-test was used for comparison of left and right side test scores, otherwise the Mann-Whitney U test was used. If the data obeyed normal distribution, the paired samples t-test was used to analyze the difference in FMS total scores before and after the intervention, otherwise the Wilcoxon Test was used.

3.3. Measurement methods

Using the measurement method, based on the FMS Functional Screening Method, the measurements were administered under the guidance of a specialized teacher. The FMS Screening Kit was used to screen the students of a university for seven movements, and the students were scored strictly according to the prescribed scoring criteria.3 was defined as the level of ability to perform the functional movement pattern adequately.2 was defined as the ability to perform the functional movement pattern adequately, but with compensatory movements.1 was defined as the inability to perform the movement pattern independently.2 was defined as the inability to perform the movement pattern independently, and 0 was defined as pain. Pain was scored as 0. The FMS Functional Screening Scale is shown in Table 1.

Table 1. FMS functional screening criteria

Project score	Scoring criteria for action patterns
3	The test is completed according to the requirements of each action, and there is no other compensatory action
2	The motion of the motion is the difficulty of reducing the action
1	Unable to complete the standard action test and reduce the difficulty after the action test
0	Pain occurs when action is done, or pain occurs during a different test

4. Analysis of the factors influencing the movement patterns of track and field specialization

In this section of the study, the kinematic factors affecting specialized jump height, throwing and movement speed were clarified through multiple linear regression analysis. In addition, the activation intensity of each muscle group in different action segments of the specialized movement pattern was comparatively analyzed to clarify the characteristics of muscle activation intensity, so as to better clarify the training needs of the specialized movement pattern. The aim is to clarify the kinematic factors and muscle activation intensity characteristics of college track and field athletes' special movement patterns, and to provide a basis for optimizing the construction of track and field training programs.

4.1. Specialized Jump Movement Patterns

In order to explore the kinematic factors affecting the height of the in situ jump, this study used multiple linear regression to carry out further analysis. Before the regression analysis, the correlation between the common factors of each action segment and the height of the in-situ jump was analyzed, and the correlation between the common factors of the in-situ jump action pattern is shown in Table 2 (* represents $P < 0.05$, ** represents $P < 0.01$). It can be seen that the correlation between “trunk forward swing and hip and knee rotation speed” in the cushioning segment and “trunk extension speed” in the stomping and extending segment and the height of the in-situ jump is significant above the medium correlation. In addition, there was a significant correlation between the male factor “torso forward swing and hip and knee rotation speed” in the buffer session and “torso extension speed” in the stomping session.

Table 2. The correlation between the common factors of the jumping action pattern

<table>
<tr><th rowspan="2"></th><th rowspan="2"></th><th rowspan="2">Jump height</th><th>Buffer link</th><th colspan="2">Extension</th></tr>
<tr><th>The front torso is swinging at the hip and knee</th><th>The lower limb reaches the angular velocity</th><th>Torso tretch speed</th></tr>
<tr><td></td><td>Jump height</td><td>1</td><td></td><td></td><td></td></tr>
<tr><td>Buffer link</td><td>The front torso is swinging at the hip and knee</td><td>0.533**</td><td>1</td><td></td><td></td></tr>
<tr><td rowspan="2">Extension</td><td>The lower limb reaches the angular velocity</td><td>-0.032</td><td>-0.225</td><td>1</td><td></td></tr>
<tr><td>Torso tretch speed</td><td>0.745**</td><td>0.472**</td><td>0.032</td><td>1</td></tr>
</table>

Using the multiple linear regression method, a multiple linear regression model was established with the in situ jump height as the dependent variable and the three common factors obtained from the factor analysis as the independent variables. The regression analysis of the kinematic influences of the in-situ jumping movement pattern is shown in Table 3, and the metric factors of “trunk extension speed” and “lower limb extension angular velocity” can be brought into the regression model, and the pattern formula is: in-situ jumping height = 0.587+ 0.044×torso extension velocity+0.089× lower limb stirrup extension angular velocity. According to the standardized coefficients of the respective variables in the results of the regression analysis, it can be seen that the degree of influence of each variable on the height of the in situ jump in descending order is as follows: stomping and stretching torso extension speed → lower limb stomping and stretching angular velocity.

Table 3. The regression analysis of the kinematics influencing factors of the moving mode

	Nonnormalized coefficient		Normalization factor			
	B	Standard deviation	β	t	significance	VIF
(Constant)	0.587	0.034		34.291	0.000	
Torso tretch speed	0.044	0.013	0.735	5.178	0.000	1.002
The lower limb reaches the angular velocity	0.089	0.046	0.319	2.21	0.026	1.002
Model statistics						
	R^2		0.642			
	Adjusted R^2		0.592			
	F		16.285**			

The activation intensity of the lower limb muscle groups in the in situ jumping action pattern is shown in Figure 1. Comparing the activation intensity of each muscle group in the cushioning and stirrup extension sessions, only the tibialis anterior muscle in the cushioning session had a significantly higher activation intensity than that in the stirrup extension session (P < 0.01). In the stirrup extension session, gluteus maximus (P < 0.05), biceps femoris (P < 0.01), rectus femoris (P < 0.01), lateral femoris (P < 0.01), medial femoris (P < 0.01), medial gastrocnemius (P < 0.01), lateral gastrocnemius (P < 0.01) all showed higher activation intensity in the stirrup extension session.

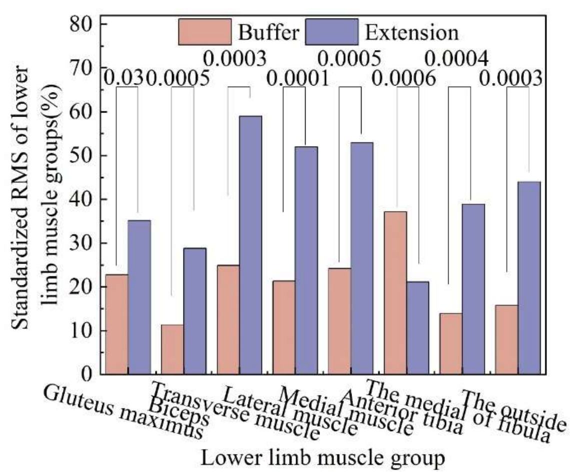

Fig. 1. The activation strength of the lower limb of the lower limb of the lower limb

The activation intensities of trunk and upper limb muscle groups in the in situ jumping action pattern are shown in Figure 2. Comparing the activation intensities of each muscle group in the cushioning and stirrup extension sessions, it can be seen that the anterior and posterior deltoid fasciculus (P<0.01), triceps brachii (P<0.01), rectus abdominis (P<0.01), and latissimus dorsi (P<0.05) all showed higher activation intensities in the stirrup extension session.

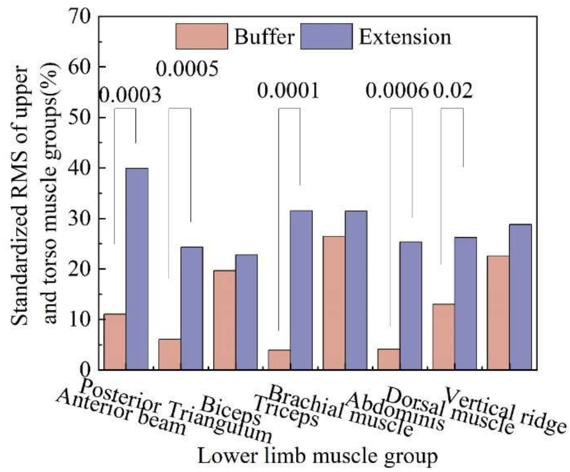

Fig. 2. The activation strength of the trunk and upper limb of the upper limb

4.2. Specialized throwing movement patterns

Before the regression analysis, the correlation between the common factors in the throwing action pattern and the hand speed at the throwing moment was analyzed, and the correlation between the common factors in the throwing action pattern is shown in Table 4. It was found that there was a strong correlation between the common factor of the arm introduction link "trunk swing velocity" and the common factor of the arm swing link "forearm swing velocity" and the hand speed at the moment of throwing. There was a correlation between the angular velocity of shoulder and elbow rotation and hand velocity at the moment of throwing, but it was not significant. In addition, in terms of the correlation between common factors, there was a significant strong correlation between the "trunk swing velocity" and the "trunk swing velocity" in the arm swing link, and there was also a medium correlation with the "forearm swing velocity", but it was not significant.

Table 4. The correlation of the common factors of the swing of the ball

			Arm connection				Swing arm		
		Punch speed	Rear forearm velocity	Rear torso speed	Shoulder, elbow speed	Front torso speed	Front forearm velocity	Elbow, wrist rotation	Shoulder, hip rotation speed
	The speed of the right hand stroke	1							
Lifting arm	Rear forearm velocity	0.034	1						
	Rear torso speed	0.682**	0.01	1					
	Shoulder, elbow speed	0.397	0.179	0.011	1				
Swing arm	Front torso speed	0.041	0.185	0.828**	-0.203	1			
	Front forearm velocity	0.735**	0.166	0.368	0.315	0.07	1		
	Elbow, wrist rotation	-0.048	0.376	0.092	-0.434	0.13	0.116	1	
	Shoulder, hip rotation speed	0.234	0.22	0.162	0.071	0.02	-0.14	0.111	1

Using multiple linear regression analysis, a multiple linear regression model was established with the hand velocity at the moment of throwing as the dependent variable, and seven common factors derived from factor analysis as the independent variables. The regression analysis of the kinematic factors affecting the throwing action pattern is shown in Table 5, and the male factors of “torso backward swing speed” and “shoulder and elbow rotation angular speed” in the arm-guiding link were brought into the regression equation, and the formula of the regression model is as follows: instantaneous hand velocity of throwing = 13.705+1.072+1.072 13.705+1.072×torso backward swing velocity+0.668×shoulder and elbow rotation angular velocity. According to the standardized coefficients of the respective variables in the results of the regression analysis, it can be seen that the degree of influence of each variable on the throwing performance was, in descending order: torso back swing velocity → shoulder and elbow rotation angular velocity.

Table 5. The regression analysis of the kinematics influencing factors

	Nonnormalized coefficient		Normalization factor			
	B	Standard deviation	β	t	significance	VIF
(Constant)	13.705	0.255		55.663	0.000	
Rear torso speed	1.072	0.265	0.626	4.07	0.001	1.012
Shoulder, elbow speed	0.668	0.267	0.372	2.286	0.033	1.012
Model statistics						
	R^2		0.625			
	Adjusted R^2		0.591			
	F		12.311**			

The activation intensity of the upper limb muscle groups in the throwing action pattern is shown in Figure 3. Comparing the activation intensities of each muscle group in the lead arm and arm swing sessions, it can be seen that the ulnar and radial wrist flexors showed higher activation intensities in the arm swing session (P < 0.01). In addition, the triceps brachii showed an increase in activation intensity in the arm swing session compared to the lead arm session, but it was not statistically significant (P = 0.08), and the activation intensities of the other muscle groups did not differ significantly between the two sessions. Of note, kinematic analysis revealed that shoulder and elbow rotation angular velocity influenced arm swing performance; however, the triceps did not show higher activation intensity.

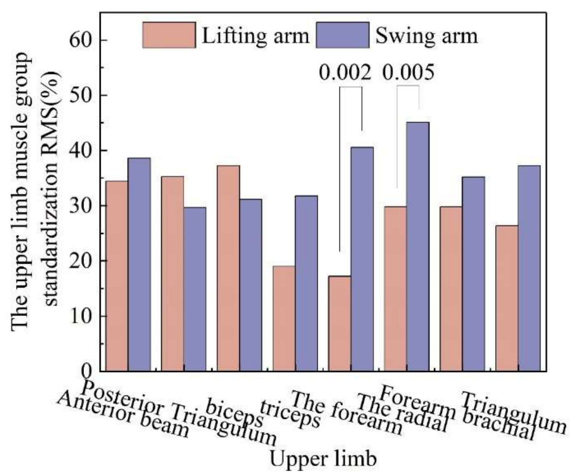

Fig. 3. The activation strength of the upper limb muscle group of the ball

The activation intensities of the trunk muscle groups in the throwing action pattern are shown in Figure 4. Comparing the activation intensities of each muscle group in the lead-arm and arm-swinging sessions, it can be seen that in the arm-swinging session, the activation intensities of the rectus abdominis and vastus dorsi were significantly higher than those in the lead-arming session, and the activation intensities of the other muscle groups did not have significant differences in the two action sessions.

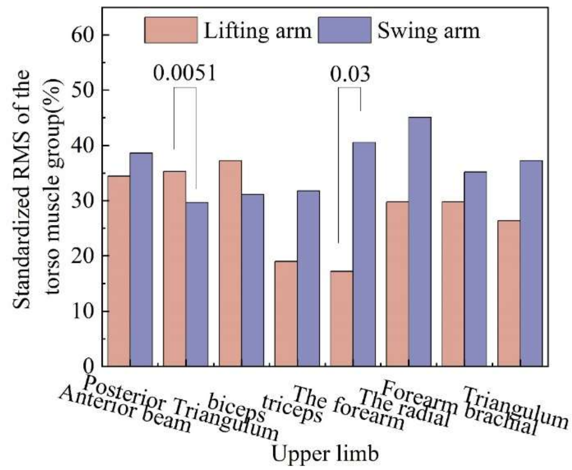

Fig. 4. The activation strength of the torso muscle group of the ball

4.3. Specialized mobile movement patterns

In order to explore the kinematic factors affecting the speed of crossstep, this study used multiple linear regression analysis to explore the kinematic factors affecting the speed of crossstep on the basis of factor analysis. Before the regression analysis, the correlation between the common factors of each link of the cross-step movement mode and the cross-step movement speed was analyzed, and it was found that the common factors of the first step of the cross-step "non-directional side of the lower limb pedaling angular velocity", the second step of the cross-step common factors "the direction side of the lower limb pedal extension velocity" and "the non-direction side of the lower limb rotation velocity", and the third step of the cross-step common factors "direction side lower limb joint velocity" and "direction side calf displacement velocity" were significantly correlated with the horizontal velocity of the center of gravity of the cross-step movement action mode. The correlation of common factors in the cross-step movement mode is shown in Table 6.

Table 6. The correlation between the common factors of the moving action pattern

		Third step		Second step		First step	
	The average velocity of the center of gravity	Angular velocity of the lateral lower limb	The displacement velocity of the lateral calf	Direction of the lower limb	The speed of the swing of the lower limb in the direction	Non-directional lateral lower limb elongation angular velocity	The velocity of swing of the lower limb
The average velocity of the center of gravity	1						
Angular velocity of the lateral lower limb	0.556**	1					
The displacement velocity of the lateral calf	0.516*	0.025	1				
Direction of the lower limb	0.569**	0.602**	0.361	1			
The speed of the swing of the lower limb in the direction	0.434*	0.267	0.331	0.002	1		
Non-directional lateral lower limb elongation angular velocity	0.577**	0.484*	-0.177	0.433*	0.338	1	
The velocity of swing of the lower limb	-0.249	-0.275	0.091	-0.014	0.316	0	1

The multiple linear regression model was established by using the multiple linear regression method, taking the average velocity of the center of gravity of cross-step movement as the dependent variable and the six common factors obtained by factor analysis as the independent variables. The regression analysis of the kinematic influencing factors of cross-step movement speed is shown in Table 7, and the common factors of the first step of cross-step "direction side lower limb rotation velocity" and the second step link common factors "direction side lower limb pedal extension velocity" and "non-direction side lower limb rotation velocity" can be brought into the regression equation, and the model formula is as follows: cross-step movement speed = 1.5 + 0.154× second step direction side lower limb extension velocity + 0.127× second step non-directional side lower limb rotation velocity +0.13×The speed of rotation of the lower limb on the side of the direction of the first step. According to the normalized coefficients of each variable in the regression analysis results, the influence of each variable on the crossstep movement speed is as follows: the lower limb pedal extension velocity on the second step direction→ the lower limb rotation velocity on the non-directional side of the second step→ the lower limb rotation velocity on the first step direction.

Table 7. The regression analysis of the kinematics influencing factors

	Nonnormalized coefficient		Normalization factor			
	B	Standard deviation	β	t	significance	VIF
(Constant)	1.5	0.042		49.485	<0.001	
The third step is the velocity of the lower limb	0.154	0.029	0.686	5.797	<0.001	1.022
The speed of the swing of the lower limb in the second step	0.127	0.039	0.555	4.854	<0.001	1.142
The speed of the swing of the lower limb in the first step	0.13	0.056	0.33	2.258	0.032	1.162
Model statistics						
	R^2		0.775			
	Adjusted R^2		0.741			
	F		22.521**			

The activation intensity of the lower limb muscles in the crossover step movement pattern is shown in Figure 5. In the crossover step movement, the difference in the form of bilateral lower limb movement led to a large difference in the activation intensity of the muscles. In the directional leg, the activation intensity of the medial and lateral gastrocnemius, gluteus maximus, and biceps femoris was higher to accomplish the stirrup-extension and forward-swing movements of the lower limb. In the non-directional leg, only the tibialis anterior showed high activation intensity, while the activation intensity of the other muscle groups was low.

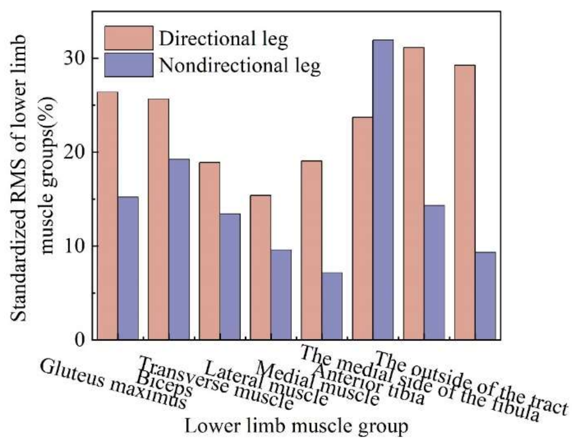

Fig. 5. The activation strength of the lower limb of the lower limb

In summary, it can be seen that in the jumping movement pattern of track and field sports, the trunk forward swing and extension speed, and the lower limb stirrup extension angle speed are the kinematic factors affecting the performance of jumping movement. In the throwing movement pattern, the backward swing speed of the torso in the lead arm and the forward swing speed of the forearm in the swing arm are the key factors affecting the performance of the throwing movement. In the movement pattern, directional leg swing and stirrup extension angular velocities, as well as non-directional leg swing velocities, influenced the crossover movement velocity, with the directional leg stirrup extension angular velocity having the highest degree of influence on the crossover movement velocity.

5. Analysis of Functional Movement Screening Results for Different Athletic Events

After analyzing the influencing factors of track and field special movement patterns in college sports through the use of multiple linear regression model, and on the basis of clarifying the training demand of track and field special movement patterns, this section combines the theoretical study of functional movement screening with the actual practice of track and field sports, and conducts the FMS test on college track and field athletes to summarize the characteristics of the movement dysfunction that exists in the body balance and joint extension during the test process, and takes the The results of the FMS test were used as a benchmark to optimize the track and field training program, reduce the chance of injury in track and field, and improve the sports performance.

5.1. Comparative analysis of total scores of functional movement screening results in different track and field events

The descriptive statistics of FMS screening scores of high school track and field athletes in each event are shown in Table 8.The statistics of Functional Movement Screening (FMS) scores among the various disciplines in track and field showed that the overall mean value of the middle and long distance events was the largest at 15.33±1.26 points, followed by the throwing events (15.12±1.65 points), the jumping events (15.02±1.25 points) ranked the third, and sprinting events were relatively low (14.2±1.32 points).

Table 8. Track and field athletes are screened for various scores and descriptive statistics

Special purpose	Sprinting	Middle run	Pelt	Skip class
FMS	14.2±1.32	15.33±1.26	15.12±1.65	15.02±1.25

Pairwise comparison of FMS screening scores of each program is shown in Table 9, and two-by-two comparisons revealed that there was no significant difference in the FMS scores of each program group (P>0.05), indicating that all outstanding athletes were tested according to the unified standard, which ensured the validity of the test.

Table 9. Screening scores were paired

				95% confidence interval	
(I)Grouping	(J)Grouping	Mean difference(I-J)	P	Lower limit	Upper limit
Throwing class	Sprinting	0.62156	0.526	-0.5754	1.2135
	Skip class	0.28641	0.761	-0.7814	1.0639
	Middle run	-0.07443	0.49	-1.2128	0.6184
Sprinting	Throwing class	-0.48743	0.496	-1.1948	0.6008
	Skip class	0.11149	0.752	-1.0732	0.7174
	Middle run	-0.54814	0.198	-1.4958	0.276
Skip class	Throwing class	-0.17751	0.748	-1.0529	0.7507
	Sprinting	0.02571	0.726	-0.7431	1.0644
	Middle run	-0.6548	0.323	-1.3929	0.4381
Middle run	Throwing class	0.14366	0.52	-0.629	1.1953
	Sprinting	0.82678	0.17	-0.3024	1.511
	Skip class	0.32592	0.311	-0.4469	1.3795

5.2. *Comparative analysis of individual items of functional movement screening results in athletes from different track and field events*

In this study, all track and field athletes were categorized into four groups: sprinters, middle distance runners, jumpers, and throwers to conduct a comparative study. Comparison of the functional movement screening scores of the athletes in different events is shown in Figure 6 (DS is Deep Squat, HS is Hurdles Rack, IL is In-Line Lunge, SM is Shoulder Mobility, ASLR is Supine Single Leg Straight Leg Raise, TSPU is Push-Up, and RS is Rotational Stability Screening). The average scores of each functional screening movement in the four events of sprinting, middle-distance running, throwing and jumping can be seen in detail in the graph, from which it can be seen that shoulder flexibility scored the most in the middle-distance running event with a score of 2.67, and the least score was also in the rotational stabilization screening movement in the middle-distance running event with a score of only 1.6. The closeness was highest in the test scores for the two movements of linear lunge, hurdle racking step, trunk stabilization push-up and trunk rotational stabilization, which were not statistically significant in terms of significance in the conclusions of the two-way ANOVA. As seen through the table, in the deep squat test movement, there was an extremely significant difference between the middle and long distance events and the sprint events (P=0.002<0.05), and the middle and long distance events were significantly different from the throwing events and the jumping events (P=0.012<0.05). In the shoulder flexibility test movement is, the middle-distance running events were significantly higher than the throwing events (P=0.042<0.05).

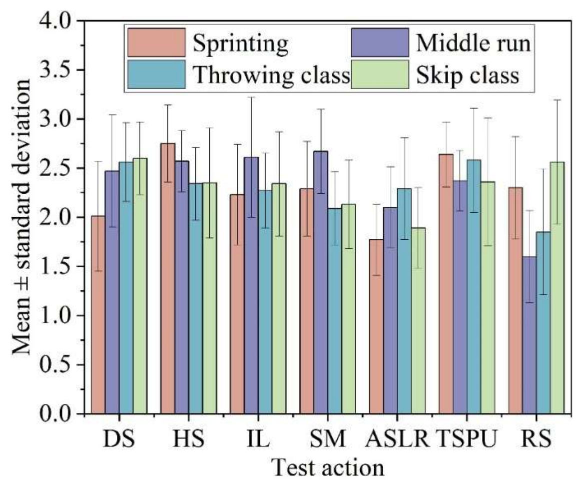

Fig. 6. Comparison of functional action screening scores of different project athletes

5.3. *Comparative analysis of functional movement screening results between field and track athletes*

The single-item comparison of FMS test for athletes in field events and track events is shown in Figure 7. As seen in the figure, the total score means of track and field athletes were close to each other, and the analysis of variance (ANOVA) of the individual items of the FMS test of athletes in track and field events is shown in Table 10. By ANOVA, there was no significant difference in the total score mean between the two (P=0.825 > 0.05). In the summary of the four single test movements of deep squat, hurdle racking step, straight line lunge, and shoulder flexibility test, the mean value of athletes in the track category was higher than that of athletes in the field category, and the mean value of the scores of athletes in the field category was higher than that of athletes in the track category in the tests of the three movements of active straight knee raise, trunk stabilizing push-ups, and trunk rotational stability, and the two movements of the shoulder flexibility test and trunk rotational stability were analyzed statistically, and there was a significant difference between the track and the field events were significantly different from each other (P=0.036<0.05, P=0.036<0.05). Further study found that the body stability and balance of field athletes were more advantageous than those of track athletes, which had a strong connection with the specialized sports, so in training, track athletes should also strengthen the body core muscle group exercise.

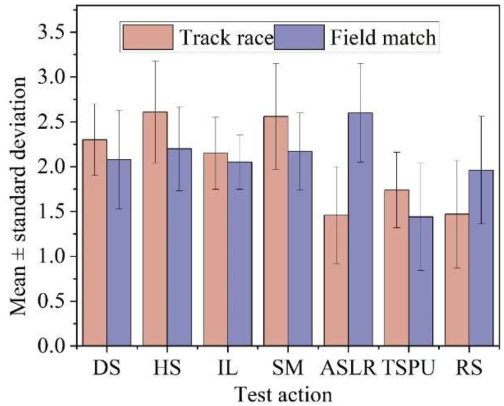

Fig. 7. Comparison of the FMS test for field and track athletes

Table 10. Test individual variance analysis

		Sum of squares	df	Mean square	F	Sig.
Squat	Between groups	0.369	1	0.427	1.522	0.235
	Within groups	23.028	77	0.295		
	Total	23.397	78			
Hurdle step	Between groups	0	1	0	0.000	1.000
	Within groups	20.741	77	0.27		
	Total	20.741	78			
Straight arrow	Between groups	0.008	1	0.115	0.491	0.495
	Within groups	18.149	77	0.25		
	Total	18.157	78			
Shoulder flexibility test	Between groups	1.225	1	1.523	5.211	0.036
	Within groups	23.448	77	0.303		
	Total	24.673	78			
Active knee lift	Between groups	0.519	1	0.306	1.122	0.285
	Within groups	20.393	77	0.26		
	Total	20.912	78			
The torso is stable	Between groups	0.326	1	0.281	1.255	0.278
	Within groups	19.307	77	0.257		
	Total	19.633	78			
Rotor stability of torso	Between groups	0.795	1	0.578	4.432	0.036
	Within groups	11.037	77	0.152		
	Total	11.832	78			
Total score	Between groups	3.242	1	0.124	0.055	0.825
	Within groups	136.103	77	2.049		
	Total	139.345	78			

5.4. *Analysis of low-scoring movements susceptible to functional movement screening in athletes in track and field events*

Because athletes in track and field events in the density of the game and long-term high-intensity special technical training, as well as in the race instead of training for the training program arrangements, the development of the body will appear left and right asymmetric phenomenon, if the training load is large, the body fatigue, there will be a compensatory situation, a simple technical action, a little flaw may lead to the failure of the whole game, in the test through the FMS In the FMS test, the movements with lower scores will be analyzed and the reasons for the low scores will be analyzed. In the trunk rotation stability test, active straight knee and leg raise test, hurdle step test and shoulder flexibility test, track and field athletes are prone to low-scoring action patterns, and this paper summarizes 8 wrong action modes, which are shoulder and elbow contact plan, body tilt to the side of the elbow flexion, low leg height on both sides, knee bend action mode, body deflection action mode, knee abduction action mode, trunk forward tilt action mode, and shoulder flexibility test action. It is mainly caused by muscle strength imbalance, poor flexibility, and limited joint movement, etc. Targeted training and regular testing should be given in future training.

6. Optimization of track and field training programmes in higher education sports

6.1. Improve the track and field training system in colleges and universities

The amount of track and field training in colleges and universities and the intensity of track and field training directly affect the scientific nature of track and field training. To ensure that the amount of training and training intensity to reach a reasonable level, you need to constantly update the concept of track and field teaching, to do to change the traditional concepts, and further strengthen the updating of the new concepts, and constantly explore new teaching methods, and combined with the actual situation of students on the teaching and training volume and intensity of training combined with the importance of colleges and universities comprehensively recognize the importance of track and field is very necessary, and the development of a relevant track and field training system can provide institutional safeguards and policy support for the future development of track and field training. Developed a relevant track and field project training system, can be carried out for its future track and field training to mention the system to protect and policy support, and recognize the role of track and field teaching, but also be able to combine it with the teaching of cultural classes, and further strengthen the integration of the two, not only can enhance the students' physical fitness, exercise after learning, to help students to relax, to achieve the purpose of a strong physical fitness, and also help students to play the role of releasing the pressure, teachers teaching cultural classes. The role of pressure, the teacher's cultural teaching process, can also be the integration of knowledge and skills of track and field training, in order to help students understand the basis of enhanced memory. The endurance of students can be cultivated through reasonable methods.

In the process of formulating the method of track and field sports, teachers need to understand the overall situation of students, but also need to combine the situation of each student, so as to combine the situation of students for grouping, to help them to carry out effective training, to control the training volume and intensity of training in the most reasonable range, and to enhance the reasonableness of the training [18]. In this process, questionnaires can be used to investigate the degree of satisfaction of the students' learning, as well as the students' physical condition and their expectations of their own results through exercise. This process also requires teachers to arrange physical examination for students to understand the actual situation of students, combined with the situation of students to strengthen the rationality of training. In the process of establishing the group, the number of people in each group should not be more than 8, most of the members of the group are in similar physical condition, and need to carry out the same amount of exercise and intensity of exercise, this process can be supervised by the members of the group, so as to carry out a reasonable control of the intensity of training.

6.2. *Reasonable control of the quality and quantity of track and field training*

The quality of track and field training is the intensity of exercise, and the quantity of track and field training is the amount of exercise. In the traditional track and field teaching process we do not have a good distinction between quality and quantity, teachers usually arrange the sports time in the winter, centralized training for students, this practice will result in the intensity of the movement and the amount of movement in a concentrated period of time is larger, the teacher does not pay attention to the accumulation of the usual, but focus on the training, which will result in the quality of the movement to be affected. Students in the process of physiological and psychological pressure is greater than they can bear, in the long run will not only bring to the students' body, but also cause students to lose interest in track and field, and the practice can not help students effectively improve the level of track and field. Physical education teachers are too concerned about the amount of exercise, which will cause the students' track and field level to remain at a certain level, there is no room for improvement, and in the college track and field training, students do not feel the sense of tension, and therefore participate in the competition will cause excessive tension, which affects their performance [19]. Thus, it can be seen that high-intensity training not only can not play a role in promoting the students' track and field level, but also counterproductive, which requires teachers to strengthen the science of track and field teaching, and promote the students' track and field level as well as the psychological aspects in normal times. Can regularly organize some track and field competitions to attract students to actively participate, so that students feel the tension of the competition, through training to allow students to overcome the fear of the heart, to play their best level, to ensure emotional stability in the process of the game, so as to minimize the possibility of errors, to help students achieve the desired results.

6.3. *Combination of intensive and specialized training*

Teachers in the teaching process should not only coordinate the amount and intensity of training, but also for different students to carry out intensive training and special training, so as to better stimulate the students' own potential, and intensive training can better help students to improve the quality of the body as well as the skills, to avoid the students head slack. Specialized training in the process of teachers should be a good screening of the content of training, involving the aspects of not too extensive, otherwise it will not play a due role, not only can not tap the potential of the students, but also can not be able to students in the process of practicing the degree of concentration to improve. Intensive training and special training will cause students to stimulate the potential of sports, strengthen the body's skills, help students to achieve balanced development, and can also enhance the effect of intensive training for students.

7. Conclusion

The article is based on a series of computational methods to test the FMS of track and field data of students in a college, and to propose a training program for college sports track and field according to the experimental results, the conclusions of the research in this paper are as follows:

Through the regression analysis of the kinematic influencing factors of the crossover step moving speed, the formula of its multiple regression model is expressed as follows: crossover step moving speed = 1.5 + 0.154 × the second step directional side of the lower limb stirrup extension angular velocity + 0.127 × the second step of the non-directional side of the lower limb swing speed + 0.13 × the first step of the directional side of the lower limb swing speed.

In the comparative analysis of the functional movement screening results of the athletes of different track and field events, the shoulder flexibility of the middle-distance running event scored the most with 2.67 points, and the least score was 1.6 points for the rotational stabilization screening movement of the middle-distance running event.

Colleges and universities need to change the traditional concept of track and field teaching, from the training volume and training intensity and other aspects of attention, combined with the actual situation of students, targeted training for students, and constantly improve the reasonableness of the training process, to achieve the combination of quantity and quality, and in the training process of intensive training and special training into.

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References

[1] Sonkeng, K., Dexter, M. R., Matz, R., Chepyator-Thomson, J. R., & Byron, K. C. (2020). Athletics/track and field. In Routledge Handbook of Global Sport (pp. 261-272). Routledge.

[2] Jing, R., Wang, Z., & Mee-Seong, C. (2025). Interventional effects of different track and field sports on human cardiovascular function indicators and physiological energy metabolism. BMC Sports Science, Medicine and Rehabilitation, 17(1), 1-11.

[3] Nikolaidis, P. T., & Son'kin, V. D. (2023). Sports Physiology in adolescent track-and-field athletes: a narrative review. Open Access Journal of Sports Medicine, 59-68.

[4] Asensio Castañeda, E., Navarro, R. M., Chamorro, J. L., & Ospina-Betancurt, J. (2023). A holistic vision of the academic and sports development of elite Spanish track and field athletes. International journal of environmental research and public health, 20(6), 5153.

[5] Tang, M., & Sun, Y. (2025). Comprehensive Analysis Using 2-tuple Linguistic Neutrosophic MADM with Core Competencies Evaluation of Track and Field Students in Sports Colleges. Neutrosophic Sets and Systems, 77, 331-354.

[6] Wang, H. (2019, January). On the Value Exploration of Track and Field Teaching in Colleges and Universities Based on the Concept of" Process Evaluation". In 3rd International Seminar on Education Innovation and Economic Management (SEIEM 2018) (pp. 521-523). Atlantis Press.

[7] Goodman, A., Mazerolle, S. M., & Eason, C. M. (2017). Organizational infrastructure in the collegiate athletic training setting, part II: benefits of and barriers in the athletics model. Journal of athletic training, 52(1), 23-34.

[8] Criticos, M., Layne, T., Simonton, K., & Irwin, C. (2020). Gender differences with anxiety, perceived competence, and grit in collegiate track and field throwers. Journal of Physical Education and Sport, 20(5), 2751-2759.

[9] Sun, J., & Liu, Y. (2020). Using smart bracelets to assess heart rate among students during physical education lessons: feasibility, reliability, and validity study. JMIR mHealth and uHealth, 8(8), e17699.

[10] Yang, C. (2021, May). Application of Computer Technology in Track and Field Physical Education. In 2021 International Conference on Computers, Information Processing and Advanced Education (CIPAE) (pp. 97-100). IEEE.

[11] Li, L., & Li, C. (2021). Retracted article: Design and implementation of track and field training information collection and feedback system based on multi-sensor information fusion. EURASIP Journal on Advances in Signal Processing, 2021(1), 51.

[12] Wu, J., & Wen, P. (2024). Track and field training information acquisition and feedback of the based wireless medical sensor network. Internet Technology Letters, 7(5), e442.

[13] Han, D. (2021). Data collection and analysis of track and field athletes' behavior based on edge computing and reinforcement Learning. Mobile Information Systems, 2021(1), 9981767.

[14] Tang, X., Long, B., & Zhou, L. (2025). Real-time monitoring and analysis of track and field athletes based on edge computing and deep reinforcement learning algorithm. Alexandria Engineering Journal, 114, 136-146.

[15] Lin, Q., Dong, X., & Li, M. (2022). Analysis of Big Data Behavior in Sports Track and Field Based on Machine Learning Model. Mathematical Problems in Engineering, 2022(1), 1439993.

[16] Hui Wang. (2024). A study on the integrated teaching model of core literacy in college physical education and health courses using multiple data fusion. Applied Mathematics and Nonlinear Sciences(1).

[17] Cheng Wenlong. (2023). Model Construction of Influencing Factors of Physical Education Core Quality Cultivation Based on Multiple Linear Regression. Applied Mathematics and Nonlinear Sciences(2),1531-1540.

[18] Ron Snarr,Will Peveler & Phillip Bishop. (2025). Measurement and Evaluation in Physical Activity Applications:Exercise Science, Physical Education, Coaching, Athletic Training, and Health. doi:10.4324/9781032719504.

[19] Ruibin Jing,Zhengwei Wang & Peng Suo. (2024). Optimization of track and field training methods based on SSA-BP and its effect on athletes' explosive power. Heliyon(3),e25465-.