International Journal for Housing Science and Its Applications
Publish August 6, 2025. Volume 46, Issue 3 Pages 5489-5497

https://doi.org/10.70517/ijhsa463474

Using time series modeling to analyze fitness fluctuations in track and field athletes across training cycles

Qingqing Zhao[1], Jialiang Li[2], Jun Li[3] and Kaikai Hou[4,*]
[1] Beijing University of Financial Technology, Beijing, 101118, China
[2] College of Physical Education, Yanching Institute of Technology, Langfang, Hebei, 065201, China
[3] Preschool and Health Department, Beijing Institute of Business and Technology, Beijing, 065200, China
[4] College of Basic Education & Physical Education Department, Beijing College of Finance and Commerce, Beijing, 101101, China
Corresponding authors: (houkaikai2022@126.com).

Abstract Track and field events place diverse demands on athletes' physical fitness. Traditional training methods have limitations, including fixed patterns, low intensity and neglect of individual differences, which make it difficult to cope with dynamic changes in events. In this study, a time series model was used to analyze the fluctuation of physical fitness of track and field athletes in different training cycles, and to explore the scientific methods to optimize the training effect and athletic status. The study selected 22 athletes at level 2 and above in track and field sprinting, jumping and hurdling events from a university, randomly divided into 11 athletes each in the experimental group and the control group, and implemented an 8-week comparison experiment. The data were analyzed by paired-sample t-test and independent-sample t-test to compare the changes of athletes' physical fitness parameters before and after training, and time series correlation analysis was applied to investigate the relationship between coaching quality and athletes' development. The results showed that the experimental group was significantly better than the control group in the standing long jump, 100 m and high jump ($P<0.001$), in which the average performance of the experimental group in the standing long jump amounted to 2.89±0.68 m, the average performance in the 100 m was 12.32±0.47 s, and the average performance in the 110 m hurdles was 20.07±1.04 s. The time-series analysis showed that the average performance of the new athletes in the 4th year of the team with the retired allocation numbers showed the highest correlation (0.653), while the effect of highly educated coaches on the level of athletes' grades also peaked at year 4 (correlation -0.689). The study shows that scientific cycle training combined with time series analysis can effectively improve athletes' physical fitness level, while the optimization of the training system needs to take into account the professional quality and practical ability of coaches, and at the same time, the cycle of athletes' success is about 4 years, which provides data support for the training planning of track and field.

Index Terms Athletics, Time series model, Training cycle, Fitness fluctuation, Specialized training, Athlete success

I. Introduction

Athletics program, as an important part of competitive sports, covers a variety of sports forms, which puts different requirements on athletes' physical fitness. Scientific training not only helps to improve athletes' athletic ability, but also is an important way to reduce sports injuries [1]. Explosive power events such as sprinting, jumping and throwing emphasize the combination of instantaneous strength, speed and explosive power, while endurance events such as long-distance running and race walking mainly rely on aerobic endurance, muscular endurance and cardiorespiratory endurance [2]-[4]. Therefore, training should not only meet the athlete's specialized requirements, but also need to reasonably allocate training intensity and recovery time through scientific cycle training methods, so as to enhance the athletic status of athletes. Traditional training methods have revealed limitations in several track and field programs. First, the traditional and lack of scientific guidance cycle training program shows a fixed pattern (competition preparation, competition process, post-competition transition) and low intensity, and can not cope with the dynamic needs of the event changes in the complexity of the situation, solidified training makes the athlete's state of fluctuation, and does not take into account the athlete's physical quality and personalized needs [5]-[8]. Secondly, over-training can easily lead to physical injuries and fatigue, and the timing of recognizing fatigue is often not grasped by the athletes and their coaches, resulting in a longer recovery cycle for the athletes [9], [10]. In addition, athletes' optimal state for competition requires appropriate adjustments, but the reality is that most athletes do not reach their optimal state during competition [11]. Therefore, it is necessary to monitor and analyze the athletes' physical parameters under different training cycles, to grasp the athletes' physical status in time, to optimize the training plan, and to contribute the best state for the competition.

In recent years, with the progress of sports science, athlete training has gradually developed from empirical training to a refined training mode based on scientific data and technical analysis. The monitoring of athletes' physical fitness data through wearable devices, athlete tracking technology, and intelligent algorithms has made up for the traditional cross-sectionalized data collection [12], [13]. However, the analysis of athletes' physical fitness is still a static analysis method, which is difficult to reflect the fluctuating characteristics of physical fitness in the time series as well as the correlation between each physical fitness data and physiological data captured, while ignoring the individual differences of athletes. Time series modeling, on the other hand, is a statistical model used to predict time series data, which can understand the trend, seasonality and periodicity in the data and make future predictions based on this information [14]. This provides a more scientific path to analyze the fluctuation of athletes' fitness.

Athletics program, as an important part of competitive sports, covers a variety of sports forms, which puts different requirements on athletes' physical fitness. Scientific training not only helps to improve athletes' athletic ability, but also is an important way to reduce sports injuries. Explosive sports such as sprinting, jumping and throwing emphasize the combination of instantaneous strength, speed and explosive power, while endurance sports such as long-distance running and race walking mainly rely on aerobic endurance, muscular endurance and cardiorespiratory endurance. Therefore, the training should not only meet the athlete's special requirements, but also need to reasonably allocate the training intensity and recovery time through scientific cycle training methods, so as to enhance the athletes' competitive status. Traditional training methods have revealed limitations in several track and field programs. First of all, the traditional and lack of scientific guidance cycle training program presents a fixed pattern (competition preparation, competition process, post-competition transition) and low intensity, and can not cope with the dynamic needs of the event changes in the complexity of the situation, solidified training makes the athlete's state of fluctuation, and does not take into account the athlete's physical quality and personalized needs. Secondly, over-training can easily lead to physical injury and fatigue, and the timing of recognizing fatigue is often not grasped by athletes and their coaches, resulting in a longer recovery cycle for athletes. In addition, the athletes' optimal state of competition requires appropriate adjustments, but the reality is that most athletes do not reach their optimal state in competition. Therefore, it is necessary to monitor and analyze the physical parameters of athletes under different training cycles, so as to grasp the physical state of athletes in time and optimize the training plan to contribute to the best state for the competition.

In recent years, with the progress of sports science, athlete training has gradually developed from empirical training to a refined training mode based on scientific data and technical analysis. The monitoring of athletes' physical fitness data through wearable devices, athlete tracking technology, and intelligent algorithms has made up for the traditional cross-sectionalized data collection. However, the analysis of athletes' physical fitness is still a static analysis method, which is difficult to reflect the fluctuating characteristics of physical fitness in the time series as well as the correlation between each physical fitness data and physiological data captured, while ignoring the individual differences of athletes. Time series modeling is a statistical model used to predict time series data, which can understand the trend, seasonality and periodicity in the data, and make future predictions based on this information. This provides a more scientific path to analyze the fluctuation of athletes' fitness.

In this study, the time series model was used to analyze the characteristics of physical fitness fluctuations of track and field athletes in different training cycles and to explore their intrinsic patterns. Through the systematic training and testing of track and field athletes in a university, the dynamic changes of various fitness indexes were recorded, and the data characteristics were analyzed by using paired-sample t-test and independent-sample t-test. At the same time, time series correlation analysis was used to explore the influence of coaching quality, athlete recruitment and allocation and other factors on the development of physical fitness, with a view to providing data support and theoretical guidance for the scientific arrangement of the training cycle of track and field sports, promoting the transformation of training methods from empirical to data-driven, and ultimately achieving the purpose of improving the athletes' competitive level.

II. Theory of specialized training in athletics

II. A. Concept and rationale for specialized training

II. A. 1) Theoretical concepts

The meaning of specialized training theory is that in sports training, all the training objectives, tasks, methods, means and loads, etc., are required to consider and arrange around the special competitions, that is, specialized competitions are the starting point and destination of the planned implementation of sports training. That is, specialization training theory. Specialized training is the inevitable trend of the development of modern athletics. Modern high-level track and field competition, the result is often a small advantage to win, reflecting the intense special competitive rivalry characteristics. Specialized training (specialization) is the only way to improve athletic performance, which has not only been embodied in the international sports world for nearly 50 years in the theory of training guidance, but also has been completely confirmed by decades of training practice in various projects, specialized training has become the consensus of many coaches and scholars, but there are still some deficiencies in the understanding of special features. Various sports training textbooks and guide books, the training content is basically divided into special training, special auxiliary training, special basic training and general training. This classification is essentially correct, in practice is also feasible, the problem is that the classification standard understanding is wrong. Usually “specialized movements” as the standard of distinction between the training content with significant differences as non-specialized content. The kinematic characteristics of movements in different programs are similar, but the dynamics of completing the movement are very different due to the intensity of the work. For example, the same is running, sprinting and long-distance running special characteristics are different. It is obviously inappropriate to count all movements with great differences as “specialized movements”.

II. A. 2) Rationale

The law of biological adaptability of the human body is the theoretical basis of specialized training, which determines our basic requirements in the training process. According to the law of adaptability in the training as much as possible to use specialized training means to organize training, athletes will continue to adapt to this form of body movement, and gradually produce adaptive changes, the formation of stable and special requirements in line with the neuromuscular adaptive structure. If the athletes are not stimulated by such specialized training contents during normal training, or the time of practice is not enough, this state has not formed a stable structure, and it is impossible to produce the corresponding results in the competition. Therefore, we should attach great importance to train and establish this adaptive structure according to the needs of the competition in ordinary training.

II. B. Training load

II. B. 1) Physiological basis

The essence of sports training is to use physical exercises as a means to purposefully and systematically apply stimuli to the athlete's organism, and through the stress and response performance of the organism, gradually make it produce training adaptation, so as to improve the athlete's athletic ability. Within a reasonable range, the greater the exercise load, the deeper the stimulus to the organism, the stronger the response, and the better the effect of training adaptation. The physiological properties of muscle are excitability and contraction, which are two basic physiological processes that are closely related but different. The stimulus that causes muscle excitation followed by contraction is composed of stimulus intensity and stimulus time, the greater the intensity, the shorter the time required for tissue excitation. The lower the stimulus intensity, the longer the duration of action required, stimulus intensity and duration of action are interdependent [15].

II. B. 2) Laws of biological adaptation

The law of biological adaptation of the human body is the basic theoretical basis for the arrangement of exercise loads. The law of biological adaptation exists in the whole biological world. The essence of sports training is to implement effective stimulation of the athlete's body and mind to induce adaptation. Modern training regards this process as the process of athletes' adaptation to the sport load [16].

II. B. 3) Classification of exercise loads

At present, in all the domestic textbooks and monographs on athletic training, the classification of the types of exercise loads is based on the nature of the subject of the exercise. According to different classification methods, we can come up with many different categories. The statistics on the classification of sports loads derived from consulting the relevant information and generalizing and summarizing [17]. According to the ability of the organism to withstand the load, the training load is divided into the following categories.

(1) Excessive loads that exceed the organism's functional capacity.

(2) Developmental loads, which enable the synthesis of adaptive proteins in a particular area and produce developmental changes in the organism.

(3) Maintenance load, which prevents the destruction of protein structures that have grown and the decline of other aspects of the organism.

(4) Restorative loads that are not sufficient to prevent degenerative changes but have a positive effect on the regenerative process.

(5) Useless load, which has no developmental, maintenance or restorative effect on the organism.

III. Subjects and methods of study

III. A. Objects of study

In this paper, the training effect of speed-based strength training on the lower limb explosive power of athletes in sprinting, jumping and hurdling events in track and field was studied.

III. A. 1) Experimental Objects

A university track and field sprints, jumps and hurdles events (110m hurdles) level 2 and above athletes 26 people, including 3 athletes of fitness, 5 athletes of the first level, 18 athletes of the second level. Due to the fact that four subjects were unable to participate in the post-training test due to injuries sustained during track and field-specific training and by other factors, the final number of people included in the data analysis was 22, of which 11 were in the experimental group and 11 were in the control group as shown in Table 1.The age of the experimental group was 18.21±0.99 years old, the height was 1.86±0.06 centimeters, the body weight was 70.22±7.42 kilograms, and the body mass index was 20.87±2.13 kg/m² and years of training was 4.72±1.83 years. The control group had an age of 17.84±1.13 years, height of 1.87±0.04 cm, weight of 69.92±4.83 kg, body mass index of 20.78±1.14 kg/m², and 4.08±1.47 years of training. These athletes had no history of injuries in the two months prior to the start of the study, were physically fit for this experimental study, and trained regularly. Prior to the start of the experiment, all test athletes were familiar with the behind-the-neck half-squat exercise, the knee-high turnover exercise, and the index tests, and had signed a written informed consent notification of the risks and benefits of the testing procedures and training regimen.

Table 1: subjects basic information

Group	Age	Height	Weight	BMI	Years of training
Experimental group	18.21±0.99	1.86±0.06	70.22±7.42	20.87±2.13	4.72±1.83
Control group	17.84±1.13	1.87±0.04	69.92±4.83	20.78±1.14	4.08±1.47

III. A. 2) Experimental equipment

The experimental period is from December 26, 2024 to February 20, 2025. The experimental test and training place is Tsinghua winter training base. The experimental equipments include two Gymaware (origin: Australia), OPTOJUMP Optical Physical Fitness Training Evaluator (origin: Italy), Segmental Timing System (origin: Japan), Free-Strength Squat Rack (origin: China), Tape Measure, Barbell Bar and Barbell Pieces.

III. A. 3) Test indicators

Before and after training, all subjects performed the behind-the-neck half-squat 1RM and above-the-knee high roll 1RM, behind-the-neck half-squat 1RM average power output and above-the-knee high roll 1RM peak power output, as well as the standing long jump, static squat jump (SJ), countermovement long jump (CMJ), depth of jump (DJ), centrifugal power utilization (EUR), reaction strength index (RSI), lower extremity stiffness (Kleg), 30-meter sprint run and 60-meter sprint run tests. Sprint Run and 60 meter Sprint Run tests.

Table 2: warm-up

Portion	Action name	Number of groups/times	Intermittence
General warm-up	Jogging	10min×1	1min
	Front plate support	6×30s	
Core muscle group activation	External bridge	1×10e	
	Internal receiving bridge	1×10e	
Closed chain muscle activation	Squatting	1×10	10s
	Prearch	1×10e	
	After the bow	1×10e	
	Mussel leg	1×10	
	Keep your legs on your back	1×10e	
	Lift straight leg	1×10e	
Open chain muscle activation	Collect straight leg	1×10e	
	Jump up	1×10	
	The hurdles are raised by the swing of the legs	1×10	
Static drawing	Upper limb muscle ligament stretching	1×10min	/

III. B. Research methodology

III. B. 1) Content of the study

The 1RM knee-high roll and 1RM behind-the-neck half-squat tests were first performed with an interval of 5 h. The SJ, CMJ, DJ, lower limb stiffness test and 30-m sprint run test were performed after an interval of 48 h. The 60-m sprint run, standing long jump and the speed value corresponding to 70% of the 1RM knee-high roll and behind-the-neck half-squat loads were performed after an interval of 24 h again, and the data were collected. All tests were performed at an outdoor temperature of about 20°C. All subjects were randomly and equally divided into two groups of 11 each, one control group (n=11) and one experimental group (n=11). Prior to testing, subjects underwent a 30-40 minute warm-up, which consisted of general warm-up activities, core muscle group activation, closed chain muscle activation, and open chain muscle activation. The test was performed after 3-5 minutes of rest. The warm-up activities are shown in Table 2.

III. B. 2) Mathematical and statistical methods

This study used SPSS22.0 software to correlate and analyze the data of the indicators of the experimental test. Paired samples t-test was taken for intra-group comparison between the experimental and control groups, independent samples t-test was taken for inter-group comparison between the experimental and control groups. The statistical results of the test index data were expressed as mean plus minus standard deviation (M±SD) and analyzed using two-sided T-test. Statistical significance was indicated when the P value was less than 0.05. When the P value was greater than 0.05, it indicated no significant difference. The variance chi-square test was also performed prior to the t-test.The t-test is a commonly used statistical method for comparing the significance of differences in the means of two groups. In this study, $P<0.01$ indicates extremely significant difference, $P<0.05$ indicates significant difference, and $P>0.05$ indicates no significant difference. It is important to note that the t-test is applicable when the sample size is small, e.g. $n<30$.

IV. Findings and analysis

IV. A. Initial diagnosis of the basic situation

The initial judgment of the basic situation is shown in Table 3, through which it can be seen that a total of 22 students were included in the study and were randomly divided into two groups, 11 in the experimental group and 11 in the control group, with a corresponding p-value of 0.254 on the indicator of age. On the indicator of height, the corresponding p-value is 0.671. On the indicator of body weight, the p-value was 0.772. In the indicator of BMI, the p-value was 0.643.

The p-values in the control and experimental groups in the specialized data were 0.734, 0.378, 0.224, 0.738, 0.679, and 0.725, respectively. The p-values corresponding to these six indicators are all greater than 0.05, so it can be concluded that:Statistically speaking, before the beginning of the experiment, there was also no significant difference between the control group and the experimental group in the six indicators of age, height, weight, BMI, years of exercise, and specialization.

Table 3: initial diagnosis of students' physical quality index

Project	Control group (n=11)	Experimental group (n=11)	t/F	P
Age	17.84±1.13	18.21±0.99	-1.174	0.254
Height(m)	1.87±0.04	1.86±0.06	-0.445	0.671
Weight(kg)	69.92±4.83	70.22±7.42	0.311	0.772
BMI	20.78±1.14	20.87±2.13	0.478	0.643
Duration of motion	5.2±1.2	5.7±1.4	-1.163	0.250
Special 1500 meters n(%)	2(12%)	4(22%)	0.132	0.734
Special 100 meters n(%)4	4(18%)	1(1%)	5.463	0.378
Special 200 meters n(%)	6(27%)	4(16%)	1.569	0.224
Special 400 meters n(%)	7(30%)	9(43%)	0.128	0.738
Special lead ball n(%)	3(12%)	2(6%)	0.179	0.679
Special jump (%)	3(12%)	5(22%)	0.126	0.725

The initial diagnosis of basic athlete qualities is shown in Table 4 and it can be seen that in the indicator of men's pull-ups, the mean values of the control group and the experimental group were 24.92 and 24.63, respectively, with a corresponding p-value of 0.139. In the indicator of men's seated forward bends, the mean values of the control group and the experimental group were 27.890 and 27.59, respectively, with a corresponding p-value of 0.926, respectively. For the indicator of men's forward solid ball throw, the mean values of the control group and the experimental group were 21.58 and 21.46, respectively, with a corresponding p-value of 0.831. For the indicator of men's touch height, the mean values of the control group and the experimental group were 2.96 and 3.02, respectively, with a corresponding p-value of 0.187. The p-values corresponding to these four basic indexes were all greater than 0.05, and statistically speaking, there was also no significant difference between the control group and the experimental group in any of the four basic indexes of seated forward bending, pull-ups, forward solid ball tossing, and touching the height before starting the experiment.

Table 4: initial diagnosis of athletes' basic qualities

Basic quality of athletes	Control group (n= 11)	Experimental group (n=11)	t	p
Uplift	24.92±2.53	24.63±3.32	0.378	0.139
Preflexion	27.89±1.58	27.59±1.46	-0.113	0.926
I'm going to throw the real ball(2kg)	21.58±3.05	21.46±3.02	-0.224	0.831
Touch high	2.96±0.22	3.02±0.12	1.367	0.187

IV. B. Analysis of athletes' indicators after the experiment

The athletes' indicators after the experiment were analyzed as shown in Table 5. The mean change of the standing long jump performance of the men's control group and the men's experimental group at the late stage of the experiment was 2.72m, 2.89m, respectively, and the corresponding P-value was 0.001, P-value was less than 0.05. Therefore, statistically speaking, there was a significant difference between the control group and the experimental group in comparison of the standing long jump performance at the late stage of the experiment.

The mean value of the 100-meter performance of the control group and the experimental group in the late stage of the experiment is 12.94s and 12.32s, respectively, and the corresponding P-value is 0.001, and the P-value is less than 0.05. The use of statistical knowledge to analyze the results can be concluded that: in the late stage of the experiment, there are significant differences and similarities in the performance of the control group's 100-meter performance and the performance of the experimental group's 100-meter performance.

The mean values of the control group and the experimental group in the high jump in the late stage of the experiment were 1.56m and 1.64m respectively, with a corresponding P value of 0.001 and a P value of less than 0.05. Using the knowledge of statistics to analyze the results, it can be concluded that: in the late stage of the experiment, there are obvious differences and similarities in the high jump performance of the control group and the high jump performance of the experimental group.

Table 5: Performance index comparison analysis

Fixed jump	Data	t	p
Control group (n=11)	2.72±0.73	7.225	0.001
Experimental group (n=11)	*2.89±0.68		
100m	Data	t	p
Control group (n= 11)	12.94±0.41	-4.62	0.001
Experimental group (n=11)	*12.32±0.47		
110m column	Data	t	p
Control group (n= 11)	21.25±1.23	-4.258	0.001
Experimental group (n= 11)	*20.07±1.04		
Jump (m)		t	p
Control group (n= 11)	1.56±0.63	5.112	0.001
Experimental group (n=11)	*1.64±0.08		
Lead ball		t	p
Control group (n= 11)	9.25±0.89	2.239	0.036
Experimental group (n= 11)	*9.94±0.97		
Long jump(m)		t	p
Control group (n= 11)	5.68±0.68		
Experimental group (n= 11)	5.63±0.59	0.263	0.804

In the late stage of the experiment, the change of the mean value of the shot put performance of the control group and the experimental group is 9.25m and 9.94m respectively, and the corresponding p-value is 0.036, which is less than 0.05. Using the knowledge of statistics to analyze, it can be concluded that: in the late stage of the experiment, there are obvious differences and similarities in the performance of the control group and the experimental group's performance in the shot put.

In the late stage of the experiment, the mean values of the long jump performance of the control group and the experimental group are 5.68m and 5.63m respectively, and the corresponding P-value is 0.804, which is greater than 0.05. Using statistical knowledge to analyze, it can be concluded that: in the late stage of the experiment, there are some differences and similarities between the control group's performance in the long jump and the experimental group's performance in the long jump.

IV. C. Time series analysis

IV. C. 1) Analysis of the correlation between uptake and distribution of athletes in athletics

Analysis tools using SPSS13.0 (Statistical Package for Sociology) among the time series graph function (time series is a set of measured values of random variables arranged in chronological order, analyzing the time series graph, you can see the essence of things from the perspective of the movement, such as the difference between several time series, a longer time series of periodicity, or forecasting the future situation), after preparing the data Cross-correlation process in Time Series of the Graphs menu is selected, where the value of Difference in the form of data conversion is taken as 1, and the time series stage is 9 (2016-2024), a total of 9 years of data, and the resulting statistical results are shown in Figure 1.

From the above graph, it can be seen that the correlation is highest at Lag number=0, which means that the correlation between the two is the highest without lag, reaching 0.653. In addition, the correlation is also high at the 4th year of lag, while the correlation of the rest of the years is not too high, and none of them is more than 0.4. This shows that in order to keep the number of first-line excellent athletes stable, improve the performance and efficiency of training, and avoid the ups and downs, we must properly maintain the number structure of the sports team. This shows that in order to maintain the stability of the number of outstanding athletes in the front line, improve the performance and efficiency of training, and avoid the ups and downs, we must maintain the structure of the number of athletes in the sports team properly, and the number of newly absorbed outstanding athletes will also have a more obvious impact on the distribution of their retirement after 4 years. To a certain extent, this is also in line with the sports world, “four years to become a talent, eight years to become a tool”, new athletes after years of training, has been able to see its potential more clearly, no development prospects will be faced with the allocation and re-employment. This is also a way to improve the performance of the track and field team's success cycle.

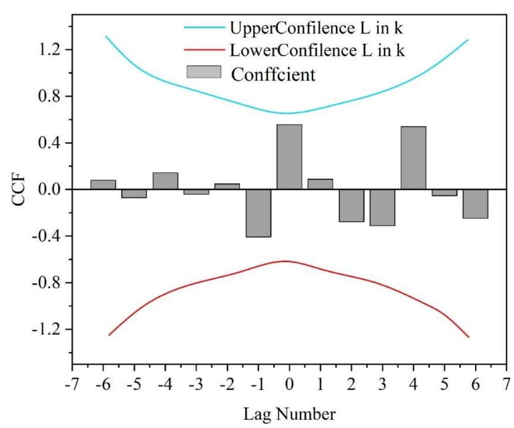

Figure 1: Time series correlation diagram

IV. C. 2) Factor analysis of rank level of track and field athletes

In order to further study the excellent track and field team college or above coaches on the number of athletes up to the level of the influence of the process, we will analyze the time series of interrelationships, the analysis tool to use the SPSS13.0 time series plot function, the specific parameters are set as follows: Difference = 1, Maxmum number of lages = 13 (a total of years 13 of information), the results are shown in Figure 2. In the above figure it can be seen that the level of 0.5 is exceeded at -0.689 when Lag number=4. The correlation is also greater at Lag number=3 and 5. The result of this analysis shows that coaches with high education level have to go through a period of time, i.e. about 4 years, before they can have a greater impact on the number of athletes reaching the level, and we analyze that it may be due to the training cycle of the athletes or it may also be that it takes a process for coaches to link the theory with practice. In a word, the practical ability of coaches outside the level of education should not be neglected, and we must seriously deal with the relationship between the two, in order to lay a good foundation for the development of China's track and field sports.

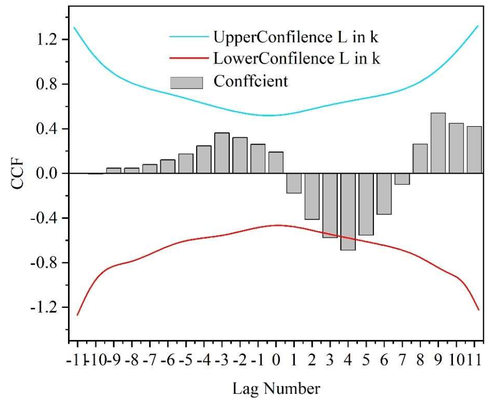

Figure 2: The relationship between the athletes' time series

V. Conclusion

This study analyzes the fluctuation of physical fitness of track and field athletes in different training cycles through time series modeling and draws the following conclusions:

Scientific specialized training can significantly improve the athletic ability of track and field athletes. The experimental results showed that the experimental group made significant progress in the standing long jump, 110-meter hurdles and high jump, in which the average performance of 110-meter hurdles reached 20.07±1.04s, which was about 5.6% higher than that of the control group's 21.25±1.23s, and the performance of shot put reached 9.94±0.97m, which was about 7.5% higher than that of the control group's 9.25±0.89m. This indicates that the targeted training design has a significant effect on the explosive power program.

Time series analysis revealed the intrinsic association between athlete success and coaching quality. The data showed that the correlation between the number of newly absorbed athletes and the number of retired assigned athletes was the highest at 0.653 when the lag period was 0. The correlation was also higher at a lag of 4 years. This confirms the empirical understanding of “four years to become a talent, eight years to become a tool” in athletics, and provides data support for the arrangement of training cycle. Meanwhile, the effect of highly educated coaches on the number of ranked athletes peaked at a lag of 4 years, with a correlation coefficient of -0.689, indicating that it takes about 4 years for coaches' theoretical knowledge to be transformed into practical effects.

There is a cyclical feature in the fluctuation of athletes' physical fitness, and training programs should be optimized according to this feature. It was found that the physical fitness parameters of athletes showed obvious fluctuation patterns in different training cycles, which is consistent with the dynamic characteristics that are difficult to be captured by traditional static analysis methods. Therefore, training arrangements should take into account the cyclical nature of physical fitness fluctuations and avoid arranging high-intensity training or important competitions during the trough period.

Individualized training program is the key to improve the training effect. Experiments show that under the same basic conditions, training programs designed for individual characteristics can produce better results. In the future, training should pay more attention to individual differences, combined with time series analysis, to develop more accurate training programs, so as to realize the continuous improvement of athletes' competitive level.

References

[1] Strüder, H., Jonath, U., & Scholz, K. (2023). Track & Field: Training & Movement Science-Theory and Practice for All Disciplines. Meyer & Meyer Sport.

[2] Kirkeberg, A., Roaas, T. V., Gundersen, H., & Dalen, T. (2022). Relative age effect among the best Norwegian track and field athletes of all time: comparisons of explosive and endurance events. Frontiers in psychology, 13, 858095.

[3] Bazyler, C. D., Mizuguchi, S., Harrison, A. P., Sato, K., Kavanaugh, A. A., DeWeese, B. H., & Stone, M. H. (2017). Changes in muscle architecture, explosive ability, and track and field throwing performance throughout a competitive season and after a taper. The Journal of Strength & Conditioning Research, 31(10), 2785-2793.

[4] Gajda, R., Kowalik, E., Rybka, S., Rębowska, E., Śmigielski, W., Nowak, M., ... & Drygas, W. (2019). Evaluation of the heart function of swimmers subjected to exhaustive repetitive endurance efforts during a 500-km relay. Frontiers in Physiology, 10, 296.

[5] Adamchuk, V., Shchepotina, N., Kostiukevych, V., Vozniuk, T., Kulchytska, I., Didyk, T., & Poliak, V. (2021). Technological Aspects of Introduction of 8-Week Model at the Phase of Direct Training for Competitions of Highly Qualified Multi-Sport Athletes in Track-And-Field Athletics. Physical Education Theory and Methodology, 21(3), 200-210.

[6] Anousaki, E., Zaras, N., Stasinaki, A. N., Panidi, I., Terzis, G., & Karampatsos, G. (2021). Effects of a 25-week periodized training macrocycle on muscle strength, power, muscle architecture, and performance in well-trained track and field throwers. The Journal of Strength & Conditioning Research, 35(10), 2728-2736.

[7] Baba, D., Mijaica, R., Nechita, F., & Balint, L. (2024). Evaluating the Effectiveness of the Annual Physical Training Plan for Masters+ 45 Women Half Marathon Athletes: A Guideline Model for Good Practices for Programming Effort Volume and Intensity. Sports, 12(9), 256.

[8] Kenneally, M., Casado, A., & Santos-Concejero, J. (2018). The effect of periodization and training intensity distribution on middle-and long-distance running performance: a systematic review. International journal of sports physiology and performance, 13(9), 1114-1121.

[9] Tsukahara, Y., Kamada, H., Torii, S., & Yamasawa, F. (2023). Association between self-reported overtraining syndrome and symptoms in high school track and field athletes. International journal of sports medicine, 44(02), 138-144.

[10] Tan, Y., Liu, Y., Ye, R., Xu, H., Nie, W., Lu, J., ... & He, B. (2020). Change of bio-electric interferential currents of acute fatigue and recovery in male sprinters. Sports Medicine and Health Science, 2(1), 25-32.

[11] Siart, B., Nimmerichter, A., Vidotto, C., & Wallner, B. (2017). Status, stress and performance in track and field athletes during the European Games in Baku (Azerbaijan). Scientific reports, 7(1), 6076.

[12] Mopas, M. S., & Huybregts, E. (2020). Training by feel: Wearable fitness-trackers, endurance athletes, and the sensing of data. The Senses and Society, 15(1), 25-40.

[13] Tan, F., & Xie, X. (2021). Recognition technology of athlete's limb movement combined based on the integrated learning algorithm. Journal of Sensors, 2021(1), 3057557.

[14] Kulakou, S., Ragab, N., Midoglu, C., Boeker, M., Johansen, D., Riegler, M. A., & Halvorsen, P. (2022). Exploration of different time series models for soccer athlete performance prediction. Engineering Proceedings, 18(1), 37.

[15] Andrew Irlitti,Thuong Hoang & Frank Vetere. (2025) .Examining the role of volumetric segmentation on movement training in mixed reality. International Journal of Human - Computer Studies,200,103499-103499.

[16] Zhang Xinwen,Feng Chengye,Xu Zhenghe,Liu Xinlin & Luo Wancheng. (2023) .The response rule of wetland microorganisms by coupling of partial nitrification process and constructed wetland. Journal of Water Process Engineering,56,104309-.

[17] Aref Smiley,Te Yi Tsai,Ihor Havrylchuk,Aileen Gabriel,Elena Zakashansky,Taulant Xhakli... & Joseph Finkelstein. (2024) .Machine Learning Approaches for Exercise Exertion Level Classification Using Data from Wearable Physiologic Monitors. Studies in health technology and informatics,310,1428-1429.