

# On the Process Control of Track and Field Training: A Systematic Review

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**Abstract:** *The training theory and methods of track and field sports have important contributions to the development of sports training. In the field of sports training, track and field sports belong to the sports group dominated by physical fitness. This paper summarizes the theory of track and field training cycle, the theory of exercise load control, the model of training process control and the theory of track and field training process control through the methods of literature and logical analysis. The research on the theory of exercise load control is based on the ability to adapt to the human body, while the research on the control model in the training process is from the aspects of mathematics and special training. The research on the physical fitness of track and field athletes, the endurance of training intensity and the sports content shows a trend of cross-integration and application. Although the above research has some limitations, it also lays a solid theoretical foundation for the exercise load theory and the training process control theory.*

**Keywords:** *track and field sports, sports training, physical fitness, training process, control theory*

## 1. Introduction

The theory of track and field training process control is developed on the basis of absorbing many natural science disciplines. With the continuous improvement and development of motion control theory, its application scope has also been expanded, which has attracted the high attention of relevant experts. The theory of motion control originated in developed countries such as Europe and America, and has made great achievements after half a century of development. On the basis of fully integrating the relevant research literature at home and abroad, this paper discusses the current situation of the theoretical research on track and field training process control. On the basis of discussing the origin of the research on the control theory of track and field training process at home and abroad, this paper introduces the theory of track and field training cycle, the theory of track and field load control, and the control mode of track and field training process. At present, the academic community has reached a consensus on the division of track and field training cycle and training structure, but there are still some differences on the arrangement of training cycle.

## 2. Literature review

In the 1960s, the Soviet Union improved the basic principle of control theory, put forward the control theory of track and field training process, and conducted in-depth research [1]. In October 1965, the first research conference on the application of control theory of track and field sports was held in Moscow. The conference mainly discussed how to apply the theory of procedural teaching control to sports training; In November of the same year, the Moscow National Institute of Sports held an academic conference with the theme of "cybernetics and sports". The participants looked at Tian from various angles

The theory of track motion control has been widely discussed, and the feasibility of its application in track and field has been analyzed. This meeting laid the foundation of control theory in sports. Since then, some scholars have begun to study this theory in depth, and have published a large number of representative theoretical works, such as *Cybernetics and Motion* by Petrovsky and *Training Regulation and Optimization* by Matviev[2].

The research on the application of control theory in physical training in the domestic academic circles originated from the research of systems theory, cybernetics and information theory groups

organized by some teaching staff of Beijing Sport University in the late 1970s. On the basis of system theory, cybernetics and information theory, Yuan and others conducted in-depth research on the application of sports control theory, and analyzed the possibility and application mode of control theory applied to sports. At present, Chinese experts have carried out a lot of research in this field, such as "The Establishment and Development of Event Group Training Theory" written by Professor Tian and "Sports Training" compiled by Professor Guo. These works systematically analyze the training mode and organizational structure of track and field sports from different aspects, and provide the guiding principles and methods of training. On this basis, other domestic experts have systematically analyzed other control theories and methods in the training process, such as the "Winning Law of China's Competitive Advantage" compiled by Xie.

To sum up, the research on sports control theory at home and abroad has been relatively mature, especially the theoretical research and training practice of some foreign track and field powers have formed a situation of mutual promotion. Although China's research started late, it has made a lot of achievements in the research of China's advantageous projects, system characteristics and training models, which has laid a certain foundation for China's scientific sports training.

### **3. The rise of the theory of periodic load control during track and field training**

#### ***3.1 The rise of foreign training cycle load control theory***

The theoretical research on load control of sports training cycle in foreign countries originated from the mid-1950s. During this period, some trainers shifted their research focus to track and field sports technology and optimization of training methods, hoping to improve the level of track and field sports through innovation of sports technology. At the beginning of the 20th century, with the development of track and field training theory, especially with the development of physiology and kinematics and other related disciplines, some scholars gradually realized the important role of athletes' physical fitness in daily training and competition. On this basis, many coaches began to try to use large exercise load as the main way to improve the training level of athletes, and achieved remarkable results. At the same time, it summarized a series of scientific training methods, such as the principle of gradually increasing the sports load on the basis of general physical training combined with specialized training put forward by the Soviet Union expert Kyrishv in the book "Soviet Union Sports Education Theory"[3]. Lacour analyzed the biochemical indexes of sprinters before and after training in track and field, providing a theoretical basis for the principle of athletes' load control. At present, the competition in track and field competitions is becoming increasingly fierce [4]. In order to improve the technical level of athletes and achieve better results in the future competitions, some experts have studied the load control in the daily training process of track and field sports. For example, Ku and others have pointed out through empirical research that repeated training before the competition has a direct impact on the results of the competition; Cheney et al. pointed out that the best performance of athletes is directly related to the specific load intensity and load capacity of athletes; Antonov pointed out that high-intensity pre-competition training has great significance and role in improving athletes' sports ability and technical level, but its impact on athletes' cardiopulmonary function is not obvious. The foreign training cycle load control theory mainly uses the principles of biology, physiology and large exercise load to conduct empirical research [5]. Through the analysis of the differences between the biochemical indicators of athletes and the athletes' special performance before and after, it proves the scientific nature of the cycle load control theory in track and field training process.

#### ***3.2 Rise of domestic training cycle load control theory***

The early training load control of Chinese track and field training is mainly based on the physiological adaptation and stimulation changes of the human body during the training process. Influenced by western culture, exercise load is controlled by several physiological indicators such as pulse, blood pressure, cardiovascular function, hemoglobin, urine protein, electrocardiogram, etc. Yin and others pointed out that the training in the preparation period during the annual training focused on the development of absolute strength, speed strength and special technical training. The load change was characterized by the parallel development and gradual increase of load and load intensity, in which the load intensity was generally controlled at the highest level of 80% - 90%. Chen and others believed that the specific time must be taken into account when using the high-load high-intensity training before the competition, and the principle of over-compensation must be combined when using the high-load high-intensity training, and the relaxation method before the major competition must be

correctly used.

Domestic experts and scholars mainly use experimental methods to adopt different load intervention methods in special training, monitor the physiological indicators and training results of athletes, and determine the intensity of exercise load at different stages through comparison before and after the experiment [6]. Based on the relevant research on the control of track and field sports load at home and abroad, experts and scholars mainly from the perspective of sports biochemistry, combined with the characteristics of athletes, apply different sports loads at different training stages, and scientifically monitor and adjust the various indicators of athletes, so as to improve the athletes' load capacity and body recovery ability, and then improve the competition results.

#### 4. Control mode in track and field training

Most scholars have studied the control mode of athletes in track and field based on the theoretical knowledge of special training, mathematics and other disciplines, mainly from the physical fitness, sports skills, psychology and other aspects of athletes. At present, there are three main forms of research on this aspect: first, the study of athletes' physical quality, skill training mode and competition mode by using mathematical methods; The second is to use mathematical methods to study the training process control mode; The third is to use data mining technology to study the visual data control mode in the training process.

##### 4.1 Research on training process control mode from the perspective of special training

From the perspective of special training, the research on the control mode of athletes' training process can be traced back to the middle and late 1920s. At that time, the coaches organized targeted physical training for the sports they were engaged in. For example, during the training process of sprinters, repeated and repeated long runs were used to promote the improvement of athletes' physical endurance. Since then, this type of training mode was called "auxiliary training". In the 1920s, the famous Finnish long-distance runner Paavo tried intermittent training in training. This new training method effectively improved his performance [7]. He won 9 gold medals in the three Olympic Games from 1920 to 1928. Before the Second World War, the German sports scientific research team tried to systematically promote interval training in German sports teams, and achieved good results in a series of track and field events. With the joint promotion of a group of researchers, such as German cardiologist Reindell and instructor Gerschler, the scientific and normative nature of interval training method has gradually strengthened [8]. According to the interval training method, if the exercise monitoring shows that the heart rate reaches 170~180 beats/min, the heart rate will be reduced to 100~125 beats/min through interval, and then the prescribed training will improve the heart pump function of the athletes, that is, Gerschlo-Reindel law. Modern interval training mode requires athletes to divide their training into multiple stages during the training process, with a certain interval between each stage, so as to improve the endurance and explosive power of athletes, which has great significance and role in improving the cardiovascular function of athletes, as shown in Table 1.

Table 1: FMS functional screening scores of track and field athletes

Name	Training years	Sport class	Total score
A	8	Athlete	18
B	9	3	26
C	6	2	31
D	6	3	28
E	4	2	26
F	4	2	19
G	3	5	17
H	3	3	21
I	2	1	32
J	4	5	21

Inspired by this, other experts have innovated the traditional training control mode, among which the "over-training mode" and "fartlek training mode" are the most representative, and have trained a large number of track and field athletes with international reputation, making outstanding contributions to the development of human sports. At the same time, some scholars have carried out a comprehensive and systematic study on the training mode. For example, Professor Janusz and others believe that the

explosive power, endurance and speed of athletes are the key factors that affect the performance of athletes in 400m hurdles[9]. In China, based on the characteristics and achievements of Ma Junren's team training, some scholars emphasized that the daily training of athletes in long-distance running should follow the training mode of "adjusting down, raising up, rushing up and practicing up". Professor Barnes and others pointed out that long-distance running training should be based on improving the physical function of athletes, because good physical function can improve the endurance of athletes, ensure that athletes can still maintain good technical and sports status under high fatigue, and avoid muscle strain and other adverse conditions; Professor Xu found through empirical research that the modern sports walking training mode is based on the ground and high step frequency.

#### 4.2 Research on the control mode of training process by using mathematical methods

Through the integration and analysis of relevant literature at home and abroad, it is found that the academic community made a major breakthrough in the theoretical research of training process control mode by using mathematical methods in the 1960s. Under the guidance of mathematical theory, Petrovsky of the Soviet Union applied control theory to track and field training for the first time. After he put forward the basic concept of training control, a new training mode appeared in the world. By applying this training mode, Borzov successfully won the gold medal in the 100m and 200m sprints at the 1972 Munich Olympic Games, which attracted the attention and attention of all sports powers [10]. The academic circles in China have applied the training control theory to track and field training since the 1980s, and have made great achievements. In 1985, Chinese sprinter Zheng broke the Asian record of 100m sprint after just two years of training. Professor Tudor Bompa and others have studied the relationship between the main wing and the main wing of sprinters, and have achieved certain theoretical results. However, because its research is aimed at individual athletes and has great limitations, it cannot be applied to the control of other special training.

#### 4.3 Research on training process control mode of visual data under big data background

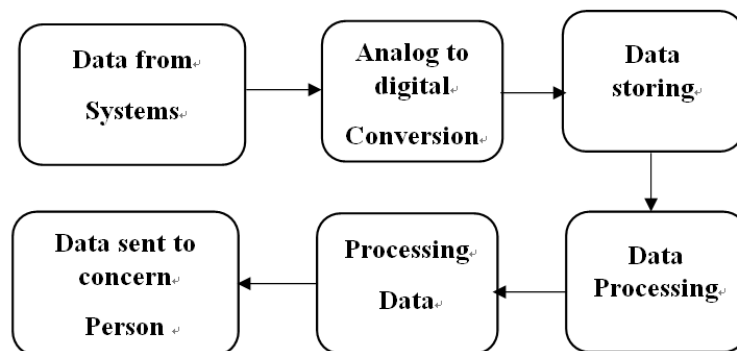


Figure 1: Visual data training process control mode

With the arrival of the era of big data, the control of training process puts forward higher requirements for the accuracy and reliability of data. A lot of data can be obtained in the process of sports training, but quite a few of them are not significant. Therefore, data should be effectively classified, that is, data should be classified into different levels according to its significant characteristics, and presented in a visual way, so as to achieve more specific, more intuitive and more effective use of data. Visual data training process control mode is a dynamic and systematic process. First of all, athletes upload data to the computer network system for data analysis in time after each training match. This process is the process of data transformation from the real world to the computer world, and finally presented in a visual way. This model is divided into three parts: completing the training or competition process; upload, process and visualize data; visual rendering. The key of the first part is that athletes should upload data timely, accurately and effectively; the key of the second part is the scientificity and effectiveness of the whole analysis system, that is, the process of effective classification of data; The third part depends on the process of athletes and coaches maintaining, adjusting or changing the training plan according to the presentation of visual results. At present, the application of visual data in the field of sports is mainly concentrated in more than 10 related disciplines such as sports psychology, sports physiology, sports injury and rehabilitation, and sports nutrition. The research hotspots of these disciplines mainly include the monitoring of physiological and

biochemical adaptation and recovery mechanism of athletes' training and competition, the monitoring of physiological mechanism of athletes' general strength training and special sports training, the monitoring of athletes' scientific training process and periodic competition process, and the monitoring of prevention and recovery mechanism of athletes' various injuries, physiological and psychological sports fatigue, the monitoring of various physiological and biochemical mechanisms of athletes and the monitoring of the training and competition cycle of athletes are shown in Figure 1, according to the characteristics of each sport.

## 5. Conclusion

Foreign academic circles have gradually strengthened the research of control theory in the daily training process of track and field, which has positive significance and role in promoting the development of this theory. In addition, international sports training scholars, coaches and athletes have a consistent attitude towards the application of various means of training and game monitoring. Now, they are gradually using multi-disciplinary and interdisciplinary methods, including information systems, sports science and statistics, for sports training monitoring, and the interpretation and application of data are also constantly improving. However, at present, China's research on the control theory of track and field training process is still in its infancy, and the depth of research is still insufficient. For example, how to establish the controllable index, the content and proportion of the controllable index, how to scientifically and effectively evaluate the controllable index, and how to compare the athletes' load capacity on the field during the competition the relationship between physical function and fitness for physical training needs further study. To solve the above problems is of great theoretical and practical significance to improve the skill level of track and field athletes and enhance their physical quality.

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