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Cooperation between Injury Prevention and Physical Recovery of College Students in Middle and Long Distance Running

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ABSTRACT

Middle-distance running is one of the most involved events in college physical education, but the incidence of sports injuries remains high. However, the existing research mostly discusses injury prevention and physical recovery separately, lacking systematic integration. In this paper, college students' middle and long-distance running group is taken as the research object. On the basis of combing the common injury types of knee joint, calf, ankle and other parts and the three-dimensional causes of training load, individual ability and recovery status, preventive strategies such as scientific load management, running posture technology optimization, special strength training, warm-up and cold-body, and recovery means such as sleep intervention, nutritional supplement, active recovery and psychological recovery are analyzed respectively. Then, starting from the underlying mechanism of collaborative logic, a four-dimensional integrated "prevention-recovery" collaborative operation model of time, means, monitoring and individual is constructed, and some suggestions such as curriculum reconstruction, log monitoring, medical and physical linkage are put forward for college physical education teaching and extracurricular autonomous training. The purpose of this study is to break the training misunderstanding of "prevention belongs to prevention and recovery belongs to recovery", and provide an integrated theoretical framework and practical path for scientific training of middle and long distance running in universities.

KEYWORDS

Middle and long distance running; Sports injury prevention; Physical recovery; Synergistic mechanism.

1. INTRODUCTION

Middle and long-distance running is one of the most involved events in college physical education curriculum and extracurricular exercise, covering typical distances such as 800 meters, 1500 meters and 5000 meters. At present, the research on injuries in middle and long distance running mainly focuses on two directions. One is to discuss injury prevention strategies from the perspective of training, such as load management, running posture optimization and special strength training [1]; The second is to analyze the means of physical recovery from the perspective of sports medicine, such as sleep intervention, nutritional supplement and active recovery [2]. However, these two directions are mostly discussed independently in the existing literature, showing an obvious split state of "prevention belongs to prevention and recovery belongs to recovery". In fact, prevention and recovery are not two unrelated links in the training chain. The quality of recovery directly determines the risk of injury in the next training, and the formulation of prevention strategies must also be based on recovery ability. There is an inherent coupling relationship between them, but it is rarely integrated by the system. Based on this, this paper takes college students' middle-distance running group as the research object, analyzes the key strategies of injury prevention and the main means of physical recovery on the basis of combing the common types and causes of injuries, and tries to build a

framework of "prevention-recovery" collaborative mechanism, with a view to providing an integrated idea for college physical education teaching and extracurricular training guidance.

2. ANALYSIS ON THE TYPES AND CAUSES OF COMMON SPORTS INJURIES OF COLLEGE STUDENTS IN MIDDLE AND LONG DISTANCE RUNNING

2.1. Common Damage Types

College students' middle and long distance running injuries involve many parts, among which knee joint and calf injuries are the most prominent. According to the relevant survey data [3], the main types and incidence of injuries are shown in Table 1.

Table 1. Types and incidence of common sports injuries in college students' middle and long distance running

Damage site	Typical damage	Incidence (reference range)
Knee joint	Chondromalacia patellae, iliotibial tract syndrome	25%—30%
Shank	Stress fracture of tibia, strain of soleus muscle	15%—20%
Foot and ankle	Achilles tendinitis and plantar fasciitis	10%—15%
Back	Lumbar muscle strain, lumbar disc herniation (a few)	8%—12%
Other	Ankle sprain, stress fracture (metatarsal, etc.)	5%—10%

From Table 1, it can be seen that the knee joint injury accounts for the highest proportion, which is closely related to the biomechanical characteristics of repeated flexion and extension of the knee joint in middle and long distance running and bearing periodic impact. However, stress injury of tibia and tendinitis of calcaneus are more common in the stage of sudden increase of training volume, which has obvious cumulative characteristics.

2.2. Cause Analysis of Damage

Based on the existing literature, the causes of college students' middle and long distance running injuries can be analyzed from three dimensions: training load, individual ability and recovery status.

(1) Training load dimension. Improper load management is the primary external cause of injury. Among college students, it is common that the weekly running volume suddenly increases by more than 10%, and the "10% incremental principle" is often ignored in actual training [4]. In addition, some college physical education courses focus on middle and long-distance running tests at the end of the semester, and students train at high frequency in a short period of time in order to meet the standards. There is an obvious gap between the peak load and physical adaptability, and the risk of injury rises sharply.

(2) The dimension of individual ability. Most of the participants in college students' middle and long distance running are non-professional athletes, and there are obvious shortcomings in their special physical fitness. The lack of strength of core muscles leads to the decline of pelvic stability during running, and the knee joint bears abnormal stress; Poor flexibility of hips and ankles will reduce running economy and increase joint compensation. In addition, unreasonable running posture further increases the load of joints and tendons, which becomes the direct mechanical inducement of injury.

(3) The dimension of recovery status. This dimension is often underestimated in previous studies, but it is especially critical for college students. College students have great academic pressure and irregular work and rest, and their sleep duration is generally less than 7 hours, and sleep is the core window of tissue repair and hormone secretion. In terms of nutrition, protein and insufficient intake of trace elements directly affect the repair efficiency of muscles and bones. More importantly, most students lack the initiative to regain consciousness. After training, they only do simple static stretching or even rest directly, and fail to promote the removal of metabolic waste through low-intensity aerobic and foam shaft relaxation. Insufficient recovery makes micro-injury accumulate continuously, and eventually it evolves from acute strain to chronic pain or even stress fracture. It can be said that the lack of recovery itself is a hidden cause of injury, and it is also a key node connecting "prevention" and "recovery".

3. THE KEY STRATEGY OF SPORTS INJURY PREVENTION

In middle and long distance running events, the occurrence of sports injuries is often the result of multiple factors. For college students, due to the pressure of schoolwork, sedentary habits and uneven basic physical fitness, preventing injuries requires not only isolated intervention measures, but also systematic strategies.

3.1. Scientific Load Management

When college students participate in middle and long-distance running, they often blindly increase the running amount because of strong motivation for preparing for the race or driven by punching mechanism, resulting in "ability-load" imbalance. Scientific load management requires the combination of master RPE (rating of perceived exertion) and objective data for double-standard monitoring. In the incremental stage, the "10% principle" should be strictly followed, that is, the total running volume per week should not exceed 10% of the previous week [5]. At the same time, it is necessary to combine the cyclical training mode of alternating big, medium and small, and reasonably arrange the "reduction week" in the semester or the preparation period to give the body sufficient adaptation time.

Load management itself is the premise of recovery. Excessive load not only directly leads to the accumulation of minor injuries, but also squeezes the recovery time, leaving the body in a state of catabolism for a long time. Reasonable load arrangement is essentially to reserve a "recovery window" for the body to ensure that the parasympathetic nerve has enough time to play its repair role; On the contrary, the scientific assessment of recovery state is also the direct basis for adjusting the training load the next day, and the two are mutually causal.

3.2. Running Posture and Technical Optimization

Abnormal running posture is a common cause of college students' middle and long-distance running injuries, especially the tension of hip flexion muscles and the inactivation of gluteal muscles caused by sedentary, which is easy to lead to excessive stride and forward leaning of trunk. The core of technical optimization is to shorten the touchdown time and reduce active work by increasing the step frequency to 180spm and above [6]; At the same time, the site is guided to be close to the center of gravity of the body, so as to avoid the braking effect caused by the heavy impact of the distal heel on the ground and the impact of the ground reaction force on the tibia and knee joint.

The essence of technical optimization is the improvement of mechanical efficiency. Good running posture can distribute the ground reaction force more evenly in the muscle-tendon complex and reduce the abnormal stress concentration in bones and joints. The optimization of stress distribution means the reduction of minor injuries, which directly reduces the "total demand" for post-match tissue repair and physical recovery at the physiological level. In addition, the improvement of movement

economy reduces invalid energy consumption, glycogen consumption and metabolite accumulation at the same pace, and accelerates the recovery of autonomic nervous system after the game.

3.3. Special Strength Training

According to the characteristics of middle and long distance running, college students need to focus on strengthening the weak links in the "power chain". Specifically, it includes strengthening the training of gluteus medius muscle to stabilize pelvis and reduce the risk of genu valgus; Strengthen the anti-rotation ability of the core and maintain the stability of the trunk during running; For the lower limbs, the eccentric training of triceps femoris and the eccentric control of quadriceps femoris are mainly introduced to improve the ability of muscles to absorb stress and prevent achilles tendinitis and patellofemoral joint pain syndrome [7]. Strength training is both a preventive measure and a physiological bridge to promote recovery. At the preventive end, strong muscles can act as better "shock absorbers" to protect passive structures. At the recovery end, through reasonable moderate and low intensity special strength training, it can produce an effect similar to "active recovery", accelerate venous blood and lymphatic reflux through muscle pump, and promote the discharge of metabolic waste; Moderate strength stimulation can trigger a slight endocrine reaction and accelerate the remodeling and excessive recovery of damaged tissues.

3.4. Warm-up and Cold Body

It is easy for college students to ignore the links of warming up and cooling down in extracurricular exercise. The complete process should include dynamic warm-up before running to raise core body temperature and activate neuromuscular joints; The cold-body part after running includes 10 minutes of low-intensity jogging or brisk walking to calm the heart rate, followed by static stretching for quadriceps femoris, hamstring and triceps surae, supplemented by relaxation of foam shaft fascia, focusing on iliotibial tract and plantar fascia. This strategy directly belongs to the recovery link and constitutes a complete closed loop of "training-recovery" [8]. Dynamic warm-up before running can prevent muscle strain by raising body temperature and increasing joint synovial fluid. Its essence is to make a "stress reserve" for the coming load and avoid extra fatigue caused by inactivity of the body. Cold body and stretching relaxation after running are the "first battlefield" for physical recovery. By using physical means to relieve muscle spasms, reduce the degree of delayed onset muscle soreness (DOMS), promote a smooth transition from sympathetic to parasympathetic nervous system, and create good physical and psychological prerequisites for the next training session.

4. THE MAIN MEANS OF PHYSICAL RECOVERY AND ITS REVERSE EFFECT ON INJURY PREVENTION

In the training system of college students' middle and long distance running, physical recovery is not a passive repair link at the end of the training chain, but a core hub to actively connect the next round of training and build a defense line for injury prevention. Scientific means of physical recovery can not only accelerate the recovery of the body, but also build a safety barrier for the follow-up training from multiple dimensions such as physiology and psychology [9], realize the two-way empowerment of "recovery-prevention", and lay the foundation for the sustainable promotion of training and the steady improvement of sports performance.

As shown in Figure 1, the four core means of physical recovery do not exist in isolation, but cooperate and support each other to jointly build a closed-loop system of "recovery, empowerment and prevention". Sleep lays a solid foundation for physical repair, nutrition provides material guarantee, active recovery activates metabolic cycle, and psychological recovery regulates training state. Through multi-dimensional synergy, the four factors move the defense line of injury prevention forward to the recovery link, realizing the transformation from passive response to injury to active

prevention, and providing a solid guarantee for the scientific and safe promotion of college students' middle and long-distance running training.

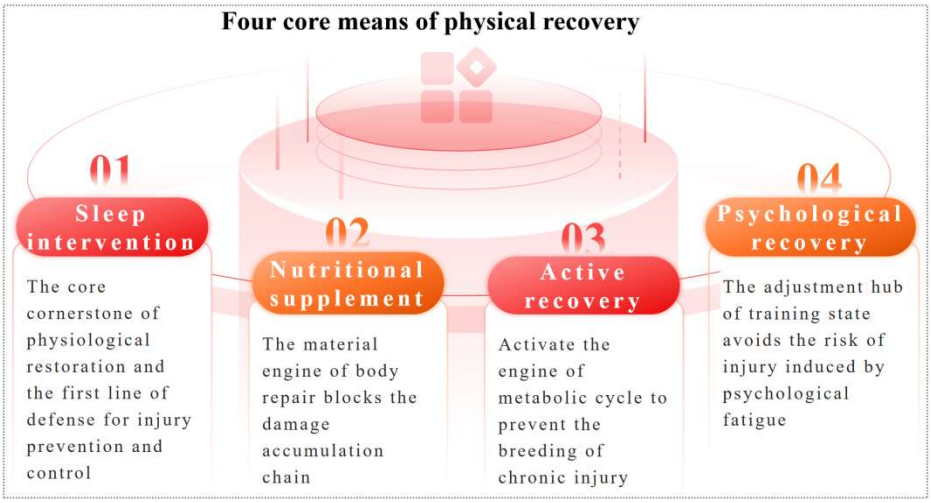

Figure 1. Four core means of college students' physical recovery in middle and long distance running

4.1. Sleep Intervention

Sleep is the key physiological process of self-repair, which plays an irreplaceable role in injury prevention of college students' middle and long distance runners. Adequate and high-quality sleep can activate the endocrine system of human body and promote the regular secretion of growth hormone. As the core regulator of tissue repair, growth hormone can effectively promote the repair and regeneration of muscle fibers, tendons, ligaments and other sports key tissues, eliminate the physiological fatigue caused by training in time and restore the structural integrity of the body [10].

From the reverse effect of injury prevention, lack of sleep will directly break the balance between body repair and load bearing. When the sleep duration is lower than the physiological demand threshold, the secretion of growth hormone is significantly reduced, the efficiency of tissue repair is greatly reduced, and the muscle elasticity and joint stability are also reduced. In the follow-up training, the risk of muscle strain and joint sprain will increase exponentially. At the same time, lack of sleep will weaken the adjustment ability of the central nervous system, which will lead to the decrease of movement control accuracy and slow response speed, and further increase the probability of acute injury caused by technical movement deformation [11]. Therefore, sleep intervention can reduce the probability of injury in follow-up training by ensuring the quality of body repair, which is the most basic and key pre-guarantee for injury prevention.

4.2. Nutritional Supplement

Nutritional supplement is the material basis for physical recovery and the core support for preventing injury accumulation. Middle and long-distance running training will consume a lot of energy reserves of the body, and at the same time cause slight muscle damage. Scientific nutritional supplement can provide sufficient raw materials for body repair by accurately supplying protein, carbohydrates, vitamins and minerals. Among them, high-quality protein is the core substrate of muscle synthesis, and adequate intake of protein can accelerate the repair and regeneration of muscle fibers and maintain muscle strength and toughness [12]; Carbohydrate can quickly replenish glycogen reserves, ensure the body's energy supply, and avoid fatigue accumulation caused by insufficient energy; Anti-inflammatory nutrients can also effectively alleviate the inflammatory reaction caused by training and reduce the continuous erosion of tissues by chronic inflammation.

The adverse effect of nutritional supplement on injury prevention is mainly reflected in the cumulative effect of blocking injury. If the nutrition intake is insufficient or the structure is unbalanced, the recovery speed of the body will lag behind the loss caused by the training load, which will lead to the failure to repair the muscle micro-injury in time, and the fatigue will continue to accumulate, which will lead to chronic strain, such as patella strain and achilles tendinitis. In addition, nutritional deficiency will also lead to decreased bone density and insufficient nutrition of articular cartilage, and increase the risk of stress fracture and joint wear [13]. Scientific nutritional supplement can protect the body's repair efficiency, maintain the healthy state of muscles, bones and joints, block the accumulated chain of injuries from the source, provide a solid physiological foundation for training, and realize active prevention of injuries.

4.3. Active Recovery

Active recovery takes low-intensity aerobic exercise, dynamic stretching and foam shaft relaxation as the core means, and accelerates the removal of metabolic waste by actively activating the circulatory system and muscle tissue, which is the key measure to prevent chronic injury. Low-intensity aerobic exercise can improve heart rate, promote blood circulation, accelerate the discharge of metabolic wastes such as lactic acid and creatine kinase, and relieve muscle soreness; Dynamic stretching can fully stretch tense muscles and fascia, improve joint mobility and improve muscle elasticity; When the foam shaft is relaxed, the muscle adhesion is released by physical pressing, which promotes the relaxation of fascia and reduces muscle stiffness and tension.

The core value of active recovery is to eliminate the breeding soil of chronic injury [14]. If there is no active recovery after training, metabolic wastes will continue to accumulate in muscle tissue, leading to continuous muscle tension and fascia adhesion, which will easily lead to chronic injuries such as fasciitis and muscle strain in the long run. Muscle tension will change the stress state of joints, increase joint pressure and induce joint wear. Active recovery can effectively prevent the occurrence of chronic injury by accelerating the removal of metabolic wastes, improving the state of muscles and fascia, maintaining muscle elasticity and joint flexibility, reducing muscle tension and joint pressure after training, providing a good physical condition for subsequent high-intensity training, and realizing the seamless connection between recovery and prevention.

4.4. Psychological Recovery

Psychological recovery is an important part of physical recovery, but it is often ignored, and its reverse effect on injury prevention is equally critical. Long-distance running training has a long period and heavy load, and athletes are prone to psychological stress, anxiety and training burnout. Psychological recovery can help athletes adjust their psychological state, rebuild their training confidence and relieve their psychological fatigue by means of stress management, training motivation maintenance and mindfulness relaxation.

The reverse effect of psychological recovery on injury prevention is reflected in avoiding the risk of training quality decline caused by psychological fatigue. When athletes are in a state of mental fatigue, it is difficult to concentrate, the ability to control technical movements is reduced, and the training enthusiasm is insufficient, which will not only greatly reduce the training intensity and standardization, but also weaken the adaptability of the body to the training load and increase the risk of acute injury caused by movement deformation and improper load bearing [15]. Psychological fatigue will also reduce the body's stress regulation ability, reduce the body's tolerance to training pressure, and further amplify the risk of injury. Scientific psychological recovery can help athletes maintain a good training state, ensure standardized training actions and reasonable load bearing, build a solid defense line for injury prevention from the psychological level, and realize the coordinated protection of psychology and physiology.

5. CONSTRUCTION OF "PREVENTION-RECOVERY" COLLABORATIVE MECHANISM FRAMEWORK

Combining the physical and mental development characteristics of college students, the movement patterns of middle- and long-distance running, and the scenario features of university classroom teaching and extracurricular independent training, this approach is based on the fundamental principle of overcompensation in sports training. It breaks away from the traditional training misconception that separates injury prevention from physical recovery. It constructs a two-way coordinated mechanism for injury prevention and physical recovery in middle- and long-distance running tailored to college students, from three aspects: the underlying logic of coordination, the multidimensional coordination operation model, and the practical implementation path. This mechanism achieves full-process closed-loop management of training load, injury prevention, physical recovery, and body adaptation, addressing the practical challenges in university middle- and long-distance running training, such as emphasizing training while neglecting recovery, and focusing on post-injury treatment while ignoring pre-injury prevention.

5.1. Intrinsic Logical Basis of Coordination between Prevention and Recovery

Middle distance running belongs to periodic endurance exercise. Continuous aerobic load and repeated lower limb kicking and landing impact will continue to bring mechanical stimulation and physiological stress to the skeletal muscles, joints, ligaments, and cardiovascular system of college athletes. Sports training itself is a reciprocating physiological process of "destruction repair adaptation", and injury prevention and physical recovery run through the entire cycle of this process. The two form a bidirectional closed-loop coupling logic. The specific physiological and training logic process is as follows:

1) Training load stimulation.
2) The body produces slight muscle injury, joint fatigue and nerve center fatigue.
3) Relying on physical recovery means to complete tissue repair and fatigue removal.
4) Achieve excessive recovery, improve the body's endurance, joint stability and muscle strength adaptability; If the recovery is insufficient, fatigue will continue to accumulate.
5) The tolerance threshold of the body decreases.
6) Under the same training load, the risk of sports injury increases greatly; If the training load is controlled by injury prevention strategy in advance, the exercise mode is optimized, and the weak muscle groups are strengthened, the amount of micro-injury can be reduced from the source and the subsequent recovery pressure can be reduced.

The complete closed-loop logical link is shown in Figure 2.

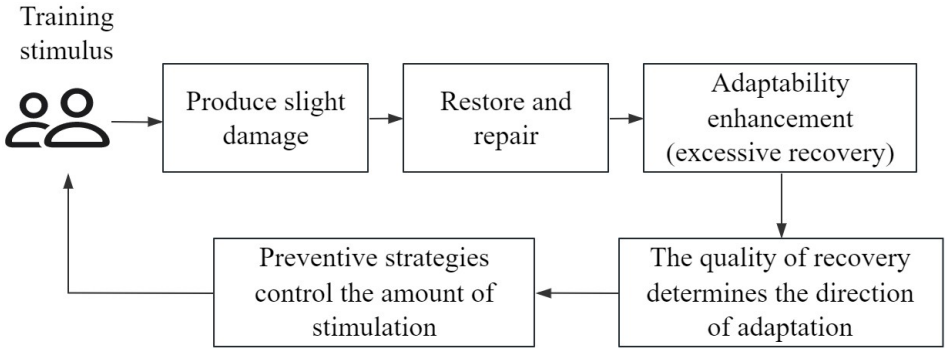

Figure 2. Physiology and training complete closed-loop logical link

Injury prevention is responsible for controlling the "input port" of training, controlling the intensity and mode of stimulation from the source to avoid acute and chronic injuries caused by overload and wrong actions; Physical recovery determines the "output result" of training, and determines whether the body can complete benign adaptation and undertake the next training load. Both of them are not independent links successively, but an integrated system of synchronous planning, synchronous implementation and synchronous monitoring, which are indispensable.

5.2. Four-dimensional Integrated "Prevention-recovery" Cooperative Operation Model

Combined with the four characteristics of college students' daily training time fragmentation, large individual differences in physical fitness level, lack of professional rehabilitation guidance and weak sense of self-recovery, an integrated collaborative model is built from four core dimensions: time, means, monitoring and individual, so as to realize the deep integration of preventive measures and recovery means and avoid the training redundancy and management loopholes caused by the separate implementation of the two schemes. The specific dimensions, operation rules and collaborative value of the model are shown in Table 2 below.

Table 2. Four-dimensional collaborative dimension detail comparison table

Collaborative dimension	Core collaborative logic	Specific implementation content	Collaborative value for college students
Time coordination	Get through the full-time nodes before training, during training and after training, prevent pre-positioning and recovery, and realize dynamic management and control of fatigue and risk.	1.Before training, dynamic warm-up+superficial fascia relaxation; 2.During training, water and electrolyte are replenished intermittently to relieve nerve fatigue in real time; 3.Immediately after training, static stretching and foam shaft relaxation can block delayed muscle soreness; 4.24-48h after training, low-intensity jogging, walking and other active recovery, with sleep management, repair deep muscle micro-injury.	It fits the rhythm of college students' single physical education class and short-term training after class, and does not need to occupy extra spare time, so as to realize the simultaneous elimination of risk prevention and fatigue in the whole training process.
Means synergy	Choose compound training methods, achieve the dual goals of injury prevention and physical recovery at the same time with the same training action, and simplify the training process.	1.Lower limb core strength training, hip bridge, lift heel, squatting against the wall, on the one hand, strengthen the stability of knee and ankle muscles, and prevent high-risk injuries such as patellar tendinitis and plantar fasciitis; On the other hand, it promotes the blood circulation of lower limbs, accelerates the discharge of metabolic waste after exercise, and helps physical recovery;	To solve the pain point of college students' lack of training time and unwillingness to carry out extra recovery training, one kind of training content takes into account two major functions and improves training efficiency.

Collaborative dimension	Core collaborative logic	Specific implementation content	Collaborative value for college students
		2.Breathing relaxation training can not only relieve chest tension during running, avoid abdominal pain caused by respiratory disorder, but also calm the excitement of sympathetic nerve and accelerate the recovery of nerve fatigue.	
Monitoring coordination	Adopt subjective and objective dual monitoring indicators, collect training load data and body recovery data synchronously, evaluate physical condition uniformly, and dynamically adjust prevention and recovery plans.	Taking RPE as the subjective index and heart rate variability (HRV) as the objective physiological index, daily synchronous monitoring of high RPE score means that the load exceeds the standard, so as to immediately strengthen injury prevention and reduce the intensity of the next training; The decrease of HRV value means that the body is not fully recovered, so we should suspend high-intensity special training, increase the duration of active recovery, and unify the balance among training, prevention and recovery.	The operation is simple and easy to use, which is suitable for the teaching scene without professional scientific research equipment in universities. Physical education teachers can quickly monitor the physical condition of the whole class in batches.
Individual synergy	Abandoning the one-size-fits-all general training scheme, combining students' previous injury history, physical foundation and gender differences, a personalized prevention-recovery pairing scheme is customized.	1.Students with old knee injuries should reduce the running load (prevention) and increase static training around the knee joint+ice therapy (recovery); 2.For girls with weak physical fitness, reduce the intensity of aerobic endurance training (prevention), extend the stretching and relaxation time, and optimize the proportion of carbohydrate and protein nutrition (recovery); 3.Beginners with zero foundation should optimize running posture teaching (prevention) and focus on low-intensity active recovery (recovery).	Take into account the polarization of college students' physical fitness, gender differences and previous injuries and injuries, improve the adaptability of the program and avoid group injuries caused by unified training.

Figure 3 below is a schematic diagram of closed-loop operation of collaborative model.

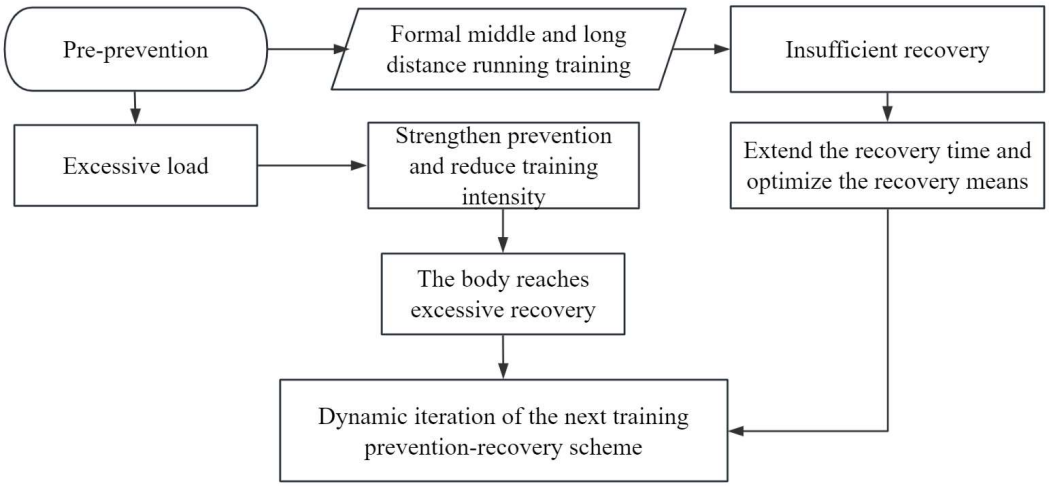

Figure 3. Schematic diagram of closed-loop operation of collaborative model

5.3. Practical Suggestions for College Physical Education Teaching and Extracurricular Training

Relying on the above-mentioned four-dimensional collaborative mechanism, combined with the three scenes of university public physical education class, after-school training of school track and field teams and students' autonomous running and exercise, this paper puts forward practical strategies that can be directly implemented from three aspects: course teaching, self-management and medical and physical linkage, so as to promote the integration of prevention-recovery collaborative mechanism into the teaching system of middle and long-distance running in universities:

(1) Reconstruct the teaching content of physical education class and embed the systematic general education of physical recovery.

Break the single teaching mode that only pays attention to running skills and endurance improvement in the current college middle-distance running course, and incorporate sports fatigue mechanism, common injury incentives, relaxation methods after running, sleep and nutrition recovery knowledge into fixed teaching hours. In the 800m/1500m classroom teaching, 15 minutes of fixed time is allocated for each class to carry out practical recovery teaching, so as to teach students to judge their own fatigue state and complete fascia relaxation and static stretching independently, and to establish the core cognition that "training must accompany recovery, and recovery is to prevent injury", and to break the inherent misunderstanding of prevention and recovery from the ideological level.

(2) Carry out unified class training-recovery log system and implement normalized self-monitoring.

A simple training recovery log is designed by physical education teachers, and students are required to truthfully record the running distance, pace, RPE fatigue score, joint discomfort, sleep duration and relaxation mode of the day during each after-school running training. Teachers uniformly review the log data every week, adjust the training intensity of students with high continuous fatigue score and joint pain separately, and match the exclusive preventive action and recovery plan one-to-one, so as to realize the normal collaborative management and control of the whole process.

(3) Establish a two-way linkage mechanism between school hospital and physical education department to realize the integrated management of injuries in the whole cycle.

Establish a normal communication channel between physical education teachers and sports rehabilitation doctors in school hospitals. For students with slight sports injuries, rehabilitation doctors will make a plan for postoperative physical recovery, and physical education teachers will simultaneously match the adaptive low-load training content and targeted injury prevention actions, so as to prevent the disconnection between "hospitals only care about rehabilitation and treatment,

and classes only care about running training". At the same time, the school hospital regularly enters the school to carry out popular science lectures, popularize the combined action of prevention and recovery, and improve the health protection system of campus sports in view of the high incidence of knee and ankle injuries of college students in middle and long distance running.

6. CONCLUSION

In this study, college students' middle and long distance running groups are taken as the object, and the multidimensional causes of sports injuries are systematically analyzed, and the internal mechanism of prevention and recovery synergy is revealed, so as to construct a four-dimensional collaborative mechanism framework with practical value. College students' middle and long-distance running injuries are characterized by high incidence of knee joints and calves, which is rooted in the superposition effect of out-of-control training load, short individual ability and insufficient recovery efficiency. A four-dimensional collaborative model is established in a breakthrough way, and the full-cycle management of "training-recovery-prevention" is realized through seamless connection of time axes, compound training design, intelligent monitoring system and personalized scheme customization. The research not only provides an operational integrated solution of "prevention-treatment-rehabilitation" for college physical education, but also clarifies the core concept of "recovery is prevention" from the level of physiological adaptation mechanism, which expands a new theoretical perspective for the field of sports training.

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