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Article

Application of sports biomechanics in improving the technical level and reducing sports injuries in athletes

Mingtao Wang*, **Zhen Pei**

School of Physical Education and Health, Xinxiang Vocational and Technical College, Xinxiang 453000, China
*** Corresponding author:** Mingtao Wang, wangmipz@163.com

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Abstract: This paper focuses on the field of sports biomechanics, and deeply explores its key applications in improving the technical level of athletes and reducing the risk of sports injury. Using rugby and football, two highly representative sports, the underlying internal link between athletes' skill level and sports injury. It has been found that gender differences in athletes and the range of exercise have different effects on the range of exercise in their muscles and joints. In studies of sport football, the data show distinct sex differences. In the male experimental group, the Angle and torque of the knee plane decreased, and those in the ankle decreased more significantly, while in the female experimental group, the knee angle increased slightly, and the ankle Angle and torque increased to varying degrees. This change shows that the adjustment of sports mechanics of the football players has a positive effect, especially male athletes, the movement significantly reduced, effectively reduce the risk of injury, fully proved the sports mechanics adjustment in reducing the key value of injury rate, help athletes to maintain good physical condition in training and competition, reduce injuries. In the study of rugby movement, in terms of hip frontal torque, the female experimental group was 8.73, which is lower than the female control group. This data intuitively shows that the female experimental group has lower damage in this dimension, reflecting that the adjustment of motor mechanics also plays an important role in rugby movement.

Keywords: sports biomechanics; technical level; sports injury; mechanical analysis

Biomechanics is a broader discipline that studies the mechanical properties and mechanical behavior of living organisms. Biomechanics covers the mechanics of the micro level to the analysis of the whole organism at the macro level. Both the growth form of plants, the movement mode of animals, and the physiological activities of human body are within the scope of biomechanics. As shown in **Figure 1**, in terms of technical support, in addition to the measurement techniques similar to motion biomechanics, it also involves materials science, computer simulation and other technologies. For example, using materials science and technology to study the mechanical properties of biological materials, such as bone and muscle, and establishing the mechanical model of biological systems through computer simulation to predict and analyze complex biomechanical phenomena. The application range of biomechanics is extremely wide, and in the medical field, it is used to study the mechanical characteristics of human bones, joints and muscles, to provide a theoretical basis for the diagnosis, treatment and rehabilitation of orthopedic diseases [1]. Khera In artificial joint replacement surgery, et al. designed appropriate joint prosthesis according to biomechanical principles to ensure its mechanical compatibility with human bones, improve the success rate of surgery and the quality of life of patients. In the field of bioengineering, biomechanical principles are used to design and optimize biomedical devices, such as cardiac pacemakers, vascular stents, etc., to ensure the safe and effective operation of these devices in the human body. Sports biomechanics is an interdisciplinary discipline that combines biology, mechanics, and sports science [2]. By definition, it mainly studies the mechanical laws of human body or sports instruments in the process of movement, and explores the stress of human body movement and the movement forms and characteristics of each part of the body. Sports injuries have always been a difficult problem for the athletes and the sports community. According to the Olympian injury report released by the World Olympic Athletes Association, knee injuries are the most common, accounting for 20.6 percent, followed by the lumbar spine and shoulder clavicle. Sports injuries not only affect the athlete's career, but may also may cause long-term damage to his physical health. Prevention of sports injuries faces many challenges. On the one hand, individual differences are significant, with each individual having varying body structure, exercise capacity, and fatigue recovery capacity, making the development of universal prevention programs almost impossible. On the other hand, the sports environment is complex and changeable, and the site conditions and climate factors are difficult to completely control and predict. Moreover, athletes' mental state, such as overconfidence, tension and anxiety, can also affect their judgment and physical control of sports, thus increasing the risk of injury.

Sports biomechanics has an irreplaceable role in the prevention of sports injuries. It can deeply analyze the mechanism of sports injury, through the biomechanical analysis of the athlete movement, to find out the wrong movement patterns and links that are easy to lead to injury. For example, in basketball, football and other projects, sudden stop sharp turn, violent torsion and other movements are easy to cause anterior cruciate ligament rupture of the knee. With the help of sports biomechanics, athletes can be targeted training and guidance in advance, strengthen the muscle strength of relevant parts, correct wrong movements, so as to effectively reduce the risk of injury. In terms of technical support, motion biomechanics uses advanced measurement technology. For example, the high-speed camera can capture the movements at extremely high frame rate, accurately capture the posture changes; the force stage can accurately measure the interaction force between the athletes and the ground, including the force size, direction and action time. These data provide a key basis for an in-depth analysis of motion biomechanics. It has a wide range of applications. In the field of sports training, coaches can find out the shortcomings in the athletes' technical movements by analyzing the movement biomechanical data of athletes, so as to make targeted training plans and improve the competitive level of athletes [3]. For example, in the sprint training, the mechanical data of the starting, en route running and sprint stage are analyzed, and the technical links such as starting posture, stride frequency and stride length are optimized to improve the sprint performance. In the research and development of sports equipment, sports shoes, sports clothes and other equipment designed according to the principle of sports biomechanics can better fit the characteristics of human sports, reduce the risk of sports injury, and improve sports performance.

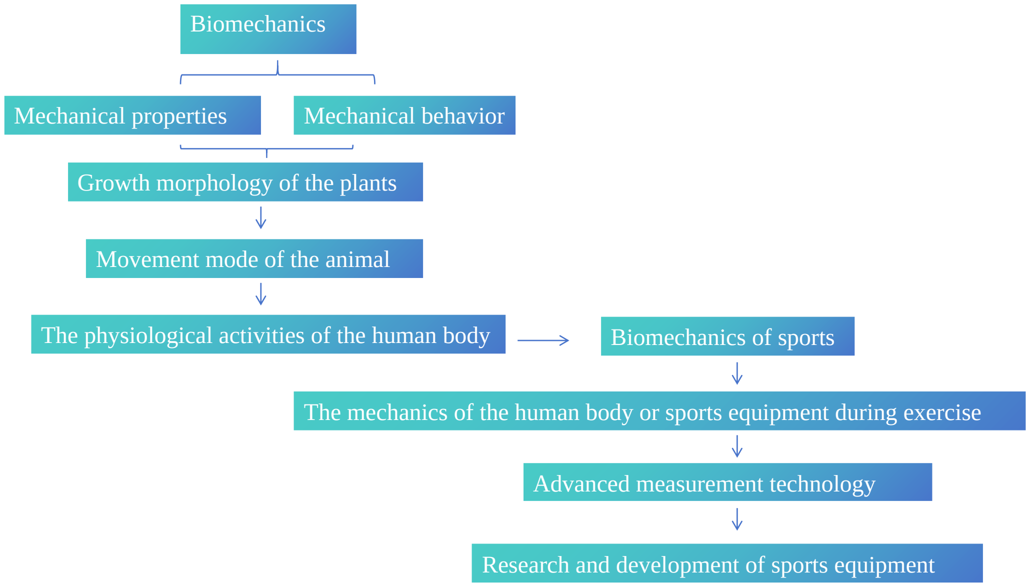

Figure 1. Logical relationship between biomechanics and movement biomechanics.

In the study of sports biomechanics in improving the technical level of athletes, representative projects with obvious visual characteristics are often studied, such as the study of pole vault biomechanics. Pole vault is a very challenging and ornamental track and field event, which combines speed, strength, coordination, flexibility and other physical qualities. Sports biomechanics, as a discipline combining biology and mechanics, provides a scientific theoretical basis and analytical method for the improvement of pole vault skills. Although the biomechanics of pole vault has been studied widely, the sport performance is measured by the height of the athlete over the horizontal pole. As the most critical link of pole vault, the take-off stage is the main focus of pole vault biomechanics research. The kinematics, dynamics and energy, including jump speed, jump distance, jump angle, ground reaction force and mechanical energy. In the run-up stage, athletes reserve their speed and energy for jumping by holding the pole quickly. The last two steps in the process of pole jumping are the most important part of the running stage. The technical actions with the characteristics of pole vault, such as lowering and lifting, also occur at this stage, as shown in **Figure 2**. From the run-up stage, the biomechanical principles have important applications. When the male athlete takes a pole vault, the arm of the male athlete will be parallel to the ground. At the highest point and the arm is perpendicular to the ground, the force of the male athlete will reach the maximum. If free fall is considered, the athlete will cross the bar with the help of inertia based on flight. The purpose of the up is to provide the athlete with sufficient horizontal speed to gain large kinetic energy when the vault is inserted. In the process of running, the body should maintain a reasonable Angle forward, stride and stride frequency should be coordinated. According to the biomechanical analysis, too large or too small stride length will affect the speed performance, and the appropriate combination of stride length and stride frequency can enable the athlete to achieve the best speed in the run-up stage. At the same time, the rhythm of the run-up is also crucial. Stable and rhythmic runs can help athletes better control the center of gravity and prepare for the subsequent pole vault. In the pole insertion and jump link, the elastic deformation of the pole and the force of the athletes are the key. When the bolt is inserted into the bucket, the impact force of the athlete bends the bolt, converting its kinetic energy into the elastic potential energy of the pole [4]. At this point, the athletes need to accurately grasp the bending degree of the pole and their own force timing. Biomechanical research shows that when the pole is bent to a certain extent, athletes should timely extend their hip and abdomen, and use the rebound force of the pole to push the body up and forward. In addition, the Angle of the pole and the ground, the height of the athlete grip pole and other factors will also affect the elastic deformation of the pole and the effect of jumping. During the flying and passing stages, the body posture adjustment has a significant impact on the performance. Athletes need to make the trajectory of the center of gravity as close as possible to the bar, thus improving the success rate of the bar. Dolatabadi think that in the process of body rise, athletes should timely close their abdomen and raise their legs, so that the body can form a tight posture and reduce air resistance. Also, the position of the head and shoulders can also affect the balance of the body and the posture over the pole. Therefore, sports biomechanics, through the accurate analysis of each technical link of pole vault, provides scientific guidance for the optimization of athletes' technical movements, and helps athletes to continuously improve their technical level in training and competition and create better results.

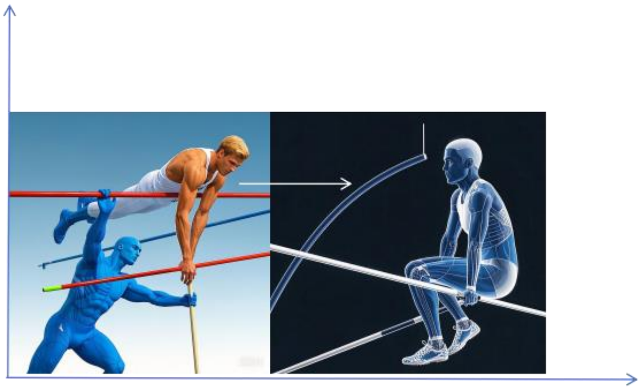

Figure 2. Schematic diagram of the analysis of motor biomechanics in the pole vault state.

As a discipline that integrates biology and mechanics principles, sports biomechanics plays a crucial role in reducing motor injuries. From the perspective of mechanics and biology, it deeply analyzes the various mechanical factors in the process of human body movement and the characteristics of body structure and function, and provides a scientific theoretical basis and practical guidance for the prevention and reduction of sports injury. In the preparatory phase prior to exercise, exercise biomechanics helps to develop a rational training plan. Through the evaluation of the body structure and sports ability of athletes, combined with the characteristics and requirements of different sports programs, to determine the intensity, frequency and mode of training suitable for individuals [5]. For example, for the knee vulnerable athletes, in the arrangement of training, according to the biomechanical principle to reduce the impact of larger action, increase targeted strength training and flexibility training, to enhance the strength of the muscles and ligaments around the knee joint, improve the stability of the joint, to reduce the risk of sports injury. Analysis of technical movements by movement biomechanics can effectively reduce the damage caused by wrong movements during movement. Take running as an example, unreasonable running posture, such as excessive internal rotation or external rotation, too large stride length, etc., will make some parts of the body bear too much pressure and stress, and long-term accumulation is easy to cause damage. Through the biomechanical analysis, it can help the athletes understand the correct running posture, adjust the movement trajectory and hair force mode of various parts of the body, so that the body can maintain a reasonable mechanical balance in the movement, reduce the local excessive load, and reduce the possibility of injury. Sports biomechanics also plays a key role in the design and selection of sports protective equipment. According to the mechanical characteristics of the human body in sports and the common damage sites, the targeted protective equipment is designed. For example, the design of sports shoes will consider the force of the foot in movement, and provide good buffer and support to reduce the impact on the foot and lower limbs on the ground; knee and wrist guards should provide stability and protection according to the anatomical structure and movement characteristics of the joint, limiting the excessive activity of the joint, thus reducing the chance of injury. In addition, sports biomechanics can also provide scientific guidance in the rehabilitation process of sports injuries. Through the mechanical analysis of the injured site, a personalized rehabilitation training program is formulated to help the athletes restore the functional and mechanical balance of the injured site, promote the comprehensive rehabilitation of the body, and prevent the secondary injury caused by improper rehabilitation. For example, in the 2010 Vancouver Winter Olympics, 2567 athletes had 287 injuries, and the overall injury rate was 11.2/100 athletes, and the injury rate of female athletes was slightly higher than that of male athletes. The injury rate at the 2014 Sochi Winter Olympics was 14/100 athletes, with female athletes still being slightly higher than male athletes. The incidence rate of injuries at the 2018 Pyeongchang Winter Olympics was observed in 12.6/100 athletes, with no significant difference between male and female athletes. In the Winter Olympics, alpine skiing, snowboarding and freestyle snow events and ice hockey have frequent injuries, especially serious injuries and knee injuries.

Table 1 shows the injury rate of some Olympic sports events based on the IOC statistics on the injury rate of all events in the Tokyo 2020 Olympic Games. The above table presents the injury rate in some parts of the Olympic Games, and a biomechanical analysis of these data gives us a deeper understanding of the underlying mechanism of injury in sports. Boxing and BMX racing had the highest injury rate at 27 percent of the same time. In boxing, the biomechanical factors were significant. The great impact of an athlete acts not only on the opponent, but also on the back of the joints and muscles of his arms and shoulders. Take straight fist as an example, the fist speed is fast, the rotation of the shoulder and arm extension action if not standard, easy to lead to shoulder muscle strain, elbow sprain. In BMX racing, riders need to frequently deal with complex terrain, such as jumping and sharp turns, when riding at high speed. These movements will make the body to bear a large inertia force and ground reaction force, when the body center of gravity control is not appropriate or landing posture is not correct, easy to cause a fall, sprain and other injuries. New items such as freestyle BMX, skateboarding and karate also had a higher injury rate, with 22%, 21% and 19% respectively. Freestyle BMX and skateboarders often perform a variety of difficult skills, such as air flipping, rotation, etc. In these movements, the movement trajectory and stress of various parts of the body are complex and changeable. Once the loss of balance or movement error, the body will bear stress beyond the normal range, thus causing damage. In karate competition, athletes' kicking, blocking and other movements need rapid force and braking, and knee joints, ankles and other parts are under great pressure in an instant. If the biomechanical mechanism is not used properly, ligament strain and joint sprain are easy to occur. The climbing injury rate is 15% and is relatively moderate in new events. When climbing, athletes need to use the grip and pedal strength of the hands and feet, and the body center of gravity is constantly changing. The muscles and tendons of the fingers, wrists and arms need to bear a large tension for a long time. At the same time, the torsion and stretching of the body on the rock wall also produce certain pressure on the spine, waist and other parts, which makes the risk of injury exist objectively, but compared with the above items, the injury rate is at the medium level. Surfing and three-man basketball injury rates were 13% and 11%, respectively, relatively low in new events. When surfing, athletes mainly use the power of the waves, and their body movements are relatively smooth and natural. Although there is the possibility of injury due to the impact of the waves and falls, the injury rate is lower than that of those events with more difficult skills and movements. In three-man basketball, although there are also physical confrontation and fast running and jumping, but because the competition field is relatively small, the collision intensity between athletes is relatively limited, so the injury rate is relatively low. The mountain bike injury rate was 7 percent, down in Tokyo compared to the Rio Olympics. This may be due to the athletes' better use of biomechanical knowledge, such as more reasonable cycling posture adjustment, which can effectively disperse the pressure of the body and reduce fatigue and damage in the waist, buttocks and other parts. Road car, diving, boating, marathon swimming and shooting events, the injury rate of 1–2%, is one of the safest events. In road cycling, posture is relatively fixed and body stress is uniform. After long-term training, diving and rowing athletes can better control their own movements and body balance, and the application of biomechanical mechanism is mature, which greatly reduces the risk of injury.

In order to further study the sports biomechanics in improving the athletes technology and avoid injury, can use the 3 d motion capture, electroG test system, computer real-time monitoring analysis system of athletes integration, discuss the ACL injury mechanism, knee injury probability, technical level and movement, the relationship between movement and injury probability, to develop an effective plan to reduce the athletes improve the athletes on the basis of technology and performance, establish a perfect evaluation method.

Table 1. Injury rate in sports events.

	Injury rate	Remarks
Pugilism	27%	With the BMX race tied for the highest injury rate
BMX Racing	27%	Boxing has the highest injury rate
Freestyle BMX	22%	New programs with higher injury rates
Chute board	21%	New programs with higher injury rates
Karate	19%	New programs with higher injury rates
Rock climbing	15%	The injury rate in the new projects was relatively moderate
Surf	13%	The injury rate in the new projects is relatively low
Three people basketball	11%	The injury rate in the new projects is relatively low
Mountain bike	7%	Tokyo injuries injuries compared to the Rio Olympics
Highway car	2%	Diving, rowing, marathon swimming and shooting are one of the safest events, with an injury rate of 1–2%

1. Principle and application of athlete sports biomechanics in improving athlete technology level

Sports biomechanics of athletes is a discipline that applies the mechanical principle to sports and studies the rules of human movement, and plays a key role in improving the technical level of athletes. From the perspective of principle, sports biomechanics can reveal the scientificity and rationality of movements through the fine analysis of athletes' movements [6]. It helps athletes to optimize the movement mode based on the principle of leverage in mechanics and Newton's law of movement. For example, in the process of running, the leg movements of the athletes constitute a complex lever system. By adjusting the timing and strength of the leg joints, it can effectively improve the running efficiency and reduce the energy loss. From the perspective of force analysis, we take the high-jump movement as an example, as shown in **Figure 3**. During the take-off stage, the athlete applies a downward force to the ground. According to Newton's Third Law, the ground gives the athlete an opposite reaction force of equal size and opposite direction. This reaction force is the key for the athlete to gain the initial upward speed [7]. At the same time, during the flying stage, the athlete is subjected to gravity, and the direction of gravity is always vertical downward, which requires the athlete to get enough vertical speed at the jump moment to overcome the gravity and reach a higher height. In addition, the attitude adjustment of athletes in the air is also closely related to the force. By reasonably changing the body posture and the position of the center of gravity, and using the weak external force such as air resistance, the high jump performance can be further optimized. Based on the theory of rigid body dynamics, the human body can be regarded as composed of multiple connected rigid bodies during motion. For example, in rugby, the analysis of these rigid movements can determine the best movement trajectory and force. According to the principle of rotational inertia, the athlete can adjust the extension degree of the body when changing the body part, which will affect the angular speed and acceleration of the rotation, so as to complete the movement in the most effective way and improve the efficiency of movement [8]. From the perspective of force analysis, taking the long jump as an example, the impulse theorem can provide us with a deeper understanding. In the run-up stage, the athletes gain the forward momentum by constantly acting with the ground. The impulse is equal to the product of force and action time. Athletes will accumulate enough large impulse in a certain time through reasonable stride frequency and stride length, so as to obtain a large initial speed. At the moment of takeoff, the impulse of the ground reaction force in the vertical direction causes the athlete to obtain the upward speed, while the horizontal impulse maintains the forward movement trend. At the same time, during the flight, the use of aerodynamic theory, athletes reasonably adjust the body posture, reduce air resistance, increase lift, so as to extend the flight distance.

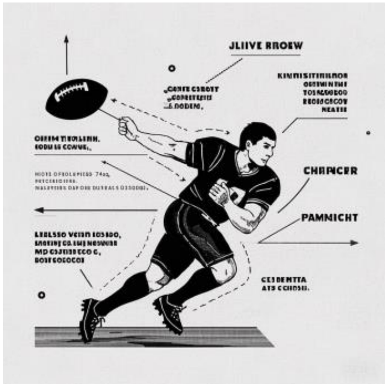

Figure 3. Analysis of the biomechanical stress movements of rugby players.

1.1. Application of motor biomechanical regulation in rugby football

In rugby, the application of biomechanics runs through the whole process of athletes' training and competition, mainly covering the key links of physical data collection, data analysis and processing, and providing guidance according to the analysis results. As shown in **Figure 4**, the data acquisition link is the basis for biomechanical applications. By arranging a number of high-speed cameras in the training and competition field, the optical motion capture system can accurately track the three-dimensional coordinate changes of the body joints when passing, catching the ball, tackling and running, so as to obtain the accurate trajectory and Angle information of the movement. At the same time, with the help of sports equipment with built-in pressure sensors, such as insoles and knee pads, it can measure the ground reaction force and muscle force under different movements. Installing sensors on rugby, it can also monitor the size and direction of the instantaneous force of passing and catching the ball [9]. In addition, with the help of wearable devices such as heart rate monitoring belts and EMG sensors, athletes' heart rate and muscle electrical activity can be recorded in real time, so as to understand the fatigue degree and working state of muscles. After the data collection, the data analysis process. Kinematic analysis will process the collected movement trajectory and Angle data, calculate the displacement, speed, acceleration and other parameters of the athletes, so as to analyze the fluency and efficiency of the movement, and judge whether the passing movement conforms to the mechanical principle and whether the passing movement can reach the farthest passing distance with the minimum energy consumption. The kinetic analysis, combined with the data collected by the force measuring equipment, analyzes the stress of athletes under different movements, finds out the patterns and characteristics of muscle force, and evaluates the load of different movements on different parts of the body. Physiological mechanics analysis combines physiological indicators with exercise mechanics data to study the changes of physical function under different exercise intensity, and to judge the fatigue threshold and recovery ability of athletes. Based on the data analysis results, we will enter into the guidance and application link. Coaches can customize training plans for athletes in different positions and with different physical qualities according to the analysis results. For example, targeted strength training courses are designed for the underpowered forwards to improve the training effect and reduce the risk of injury by optimizing the training movements. According to the biomechanical analysis results, the coach can also guide the athletes to improve the technical movements, correct the unreasonable force method in the capture movement, avoid the injury caused by improper movements, and improve the success rate of the capture movement. During the competition, the coach adjusts the tactical arrangement according to the real-time physical data of the athletes and sports mechanics data. When the muscle fatigue of a player increases, he adjusts the position or replacement in time to ensure the overall competitive level of the team. The application of biomechanics in rugby sports, through this series of closely linked links, from data collection and analysis to practical application, provides scientific and accurate support for the training and competition of rugby players, which helps to improve the athletes' competitive ability and ensure their physical safety [10].

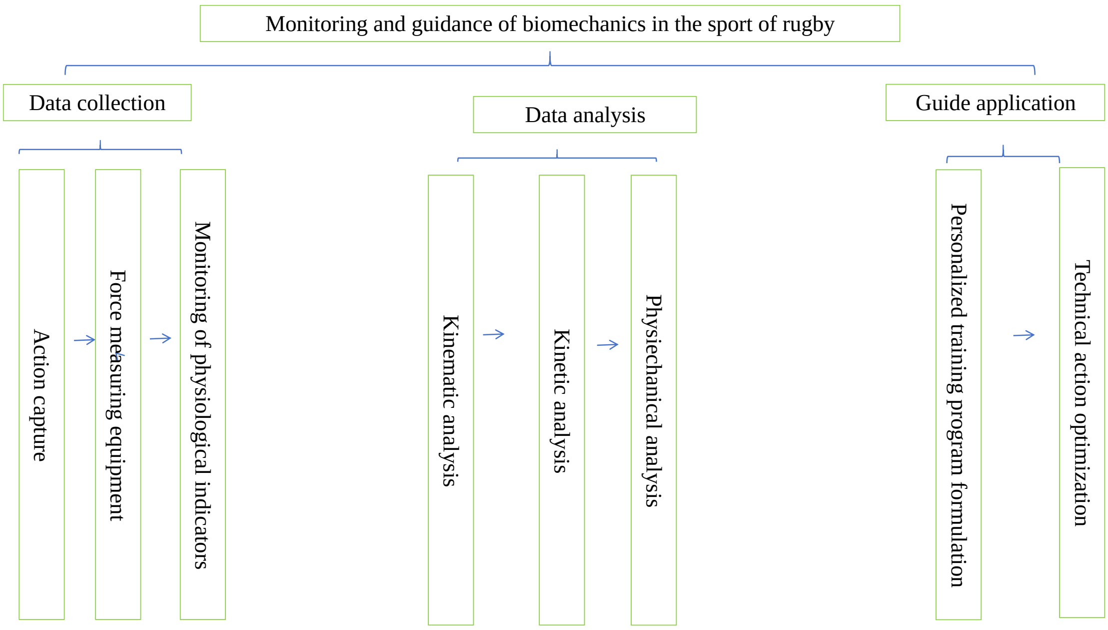

Figure 4. Biomechanics applied logic in the sport of rugby.

Table 2 shows the sports skill scoring data of rugby players after adjusting for sports mechanics status. First, the mean score of male control group was 57.83, 68.42, female control group, 55.33, and 65.33. This indicates that after the adjustment for sports mechanics, the mean sports skill scores were improved significantly in both male and female athletes, and the increase was similar among different genders. From the highest score, the male control group was 69 and the lowest score was 50; the male experimental group was 79 and the lowest score was 60. The female control group had 59 and the lowest 50; the female experimental group was 73 and 61. It can be seen that the highest score of the experimental group was higher, and the lowest score was also higher than that of the control group, indicating that the adjustment of sports mechanics not only increased the upper limit of the athletes, but also raised the lower limit, making the overall level better. From data distribution, the standard deviation was 5.31 for male, 5.35 for male experimental group, 2.87 for female, and 3.67 for female experimental group. This shows that although there are some data fluctuations in both groups, the performance of the experimental group is relatively more concentrated and the stability is increased. Through the analysis of the mean, maximum value and data distribution, it can be clearly concluded that after the adjustment of sports mechanics, athletes' sports skills are significantly improved, their performance is more stable, and the overall performance is better, which provides a strong basis for athletes to optimize the training of sports mechanics.

Table 2. Data on motor mechanics in rugby players.

	Male control group	Male experimental group	Female control group	Female experimental group
1	54	61	57	62
2	59	72	58	73
3	67	78	54	61
4	53	75	50	67
5	60	69	56	69
6	57	77	52	62
7	52	61	59	66
8	54	74	59	66
9	59	79	51	62
10	66	61	50	62
11	53	64	55	62
12	53	69	54	69
13	59	77	58	66
14	64	61	56	66
15	68	60	51	68
16	61	61	51	73
17	51	62	59	72
18	56	70	52	70
19	69	61	56	65
20	50	77	52	62
21	52	74	57	65
22	53	73	60	61
23	52	68	59	68
24	55	63	59	62

Table 3 shows the statistics of athletic muscle vitality for the rugby players in the experiment. According to the data, in terms of rectus femoris, the male experimental group increased by 5% compared with the control group, and the female experimental group increased by 2% compared with the control group; the lateral femoral muscle increased by 3% for men and 3% for women; the medial femoral muscle increased by 3% for men and women by 0%. 7% for men and 3% for women and medial ankles, 3% for men and 3% for women. Medial leg muscles, 4% for men, 4% for women; lateral leg muscles, 5% for men and 2% for women. Overall, muscle content in the experimental group increased in most areas. Among them, the lateral improvement of the ankle muscle is particularly prominent, which is very critical for the frequent direction and acceleration in rugby, which can enhance the explosive force and flexibility of the legs. Women also have a steady growth in multiple areas, which will help them better perform various technical movements during the competition. To sum up, sports mechanics adjustment makes rugby players all parts of the muscle content increased, the muscle content for the athletes on the field provides stronger support, whether running, passing, catch or fight, can perform better, effectively proved the sports mechanics adjustment to improve rugby players sports skills has played a key role [11].

Table 3. Statistics of athletic muscle vitality of rugby players.

	Male control group	**Male experimental group**	**Female control group**	**Female experimental group**
Rectus femoris	9%	14%	8%	10%
Musculus vastus lateralis	11%	14%	9%	12%
Medial vastus muscle	14%	17%	13%	13%
The lateral ankle muscle	16%	23%	15%	18%
Inside the ankle muscle	12%	15%	9%	12%
Inside the muscles of the legs	25%	29%	23%	27%
Lateral leg muscles	16%	21%	15%	17%

1.2. Application of motor biomechanical regulation in football

Table 4 shows the sports score data of football players after adjusting for sports mechanics status. The male control group ranged roughly from 31 to 50, and the data were relatively scattered. Of these, 6 data for the 31–40 segments and 14 for the 41–50 segments. The mean score was around 41.85, indicating that the overall motor skill level in the male controls was in a moderate range. The scores in the male experimental group were concentrated between 50 and 70, with only a few data below 50. There are 11 data for 50–60 data and 9 data for 61–70 points. The average score was about 58.75, an increase of about 16.9 points compared to the male control group. From the perspective of data distribution, the data of the experimental group are more concentrated and shifted to the high score segment, indicating that the adjustment of sports mechanics has a significant effect on the improvement of sports skills of male athletes. The scores in the female control group were mainly distributed between 40 and 60, with 10 data for 40–50 scores and 10 data for 51–60 scores. The mean score was around 49.7, indicating above moderate motor skill levels in the female control group. The scores were generally high in the female experimental group, mostly between 60–90, with 8 data for the 60–70 fraction, 6 data for the 71–80 fraction, and 6 data for the 81–90 fraction. The average score was about 74.35, an increase of about 24.65 points compared to the female control group. The data distribution obviously gathers to the high section, showing that the effect of sports mechanics adjustment is very prominent on the improvement of sports skills of female athletes. By comprehensively comparing the data of the control and experimental groups of male and female groups, both male and female athletes, the motor skill score improved significantly after adjusting for the motor mechanics status of kinematics. The average increase in the male group was nearly 17 points, and that in the female group was more than 24 points. This fully shows that through the reasonable adjustment of the sports mechanics state, it can effectively improve the sports skill level of athletes, and provides a strong support and scientific basis for the improvement of athletes' training and competitive performance.

Table 4. Sports skill scoring data of football players after adjusting for sports mechanics status.

	Male control group	**Male experimental group**	**Female control group**	**Female experimental group**
1	31	54	54	76
2	44	61	55	86
3	47	55	44	76
4	34	55	41	61
5	49	65	41	62
6	42	64	45	67
7	50	57	53	62
8	41	63	56	84
9	40	59	52	77
10	48	51	56	70
11	37	67	53	81
12	46	63	41	71
13	38	67	51	83
14	43	50	40	70
15	43	50	45	73
16	35	56	42	65
17	35	60	53	80
18	41	56	59	84
19	37	67	46	74
20	49	63	45	70

Table 5 shows the statistics of motor muscle vitality for the football players used in the experiment. In terms of rectus femoris, the male experimental group was 4% higher than the control group, and the female experimental group was 2% higher than the control group; the lateral muscle was 4% for men and 2% for women; the medial muscle was 3% for men and 1% for women. 5% for men and 3% for women; medial ankle, 4% for men and 2% for women. Memedial leg muscles, 6% for men, 4% for women; lateral leg muscles, 5% for men and 3% for women. It can be seen

that in both men and women, the muscle content of each part in the experimental group increased to different degrees compared with the control group. Moreover, men generally showed slightly more growth in all muscle sites than women. The increase of muscle content is important for the improvement of motor skills, and the muscle strength enhancement can provide athletes with more powerful motivation and better sports performance. By adjusting the mechanical state of kinematics, the muscle content can rise, and the athletes can better exert force, maintain the body balance and control the movements during the exercise. To sum up, after the adjustment of sports mechanics, the muscle content of all parts of the athletes is significantly increased, which undoubtedly provides a solid physiological foundation for the obvious improvement of sports skills, and strongly proves that the adjustment of sports mechanics plays a key role in improving the sports skills of the athletes.

Table 5. Statistics of athletic muscle vitality of football players.

	Male control group	**Male experimental group**	**Female control group**	**Male control group**
Rectus femoris	8%	12%	7%	9%
Musculus vastus lateralis	9%	13%	8%	10%
Medial vastus muscle	12%	15%	11%	12%
The lateral ankle muscle	15%	20%	14%	17%
Inside the ankle muscle	9%	13%	8%	10%
Inside the muscles of the legs	22%	28%	21%	25%
Lateral leg muscles	14%	19%	13%	16%

2. Principle and application of sports biomechanics in reducing body

According to the existing literature, different sports for different gender athletes selection and testing have certain differences, such as in ball rugby, female athletes relative to male athletes knee flexion Angle is smaller, leading to the ground reaction force increase, internal and external turn moment and rotating torque increase affect female athletes cruciate ligament load, leading to increase the risk of anterior cruciate ligament injury, as shown in **Figure 5** [12]. Therefore, different parameters and research hypotheses need to be set for different sports events. According to the previous biomechanical analysis of female rugby, the basic assumptions can be established based on the following assumptions. Hypothesis 1 is that the probability of ACL injury in different gender athletes [13]. Hypothesis 2 is that the movement during side running affects the anterior cruciate ligament injury and is the main cause. Hypothesis 3 shows differences in lower limb biomechanical characteristics during orientation movements for athletes with different exercise levels [14]. Hypothesis 4 effective exercise intervention can improve kinematics and exercise mechanics indicators, thus avoiding the above to some extent [15].

Figure 5. Schematic diagram of knee flexion angle force in male and female rugby players.

2.1. Rugby players sports biomechanics technical route

Figure 6 shows a technical route of a study for rugby players. First, the rugby players were divided into male and female athletes, including the control female athletes, female athletes in the intervention group, male athletes and male athletes in the intervention group. Then, three-dimensional motion analysis and EMG detection were carried out for these athletes, kinetic parameters were obtained through 3 D motion analysis, and data such as EMG activity, CI index and contribution rate were obtained by EMG detection [16]. Subsequently, the data comparative analysis was conducted, and the rehabilitation program was formulated accordingly, and the rehabilitation program was finally implemented. From the point of feasibility, the technical route has a certain rationality. Injuries investigation is the basis, which can clarify the health status of athletes and provide direction for subsequent research. 3 d motion analysis and EMG detection have been widely used in the field of sports science, with mature technology and can obtain more accurate data. Data comparison and analysis and rehabilitation program formulation, based on scientific data support, with targeted. In practice, however, there may be some challenges [17]. For example, the selection criteria of female athletes in the control group and intervention group should be strictly defined to ensure the scientific nature of comparison; the accuracy and comprehensiveness of injury information may be disturbed by many factors; the implementation effect of rehabilitation program may be affected by individual differences, training arrangements and other factors. But in general, through reasonable planning and strict implementation, the technical route is feasible.

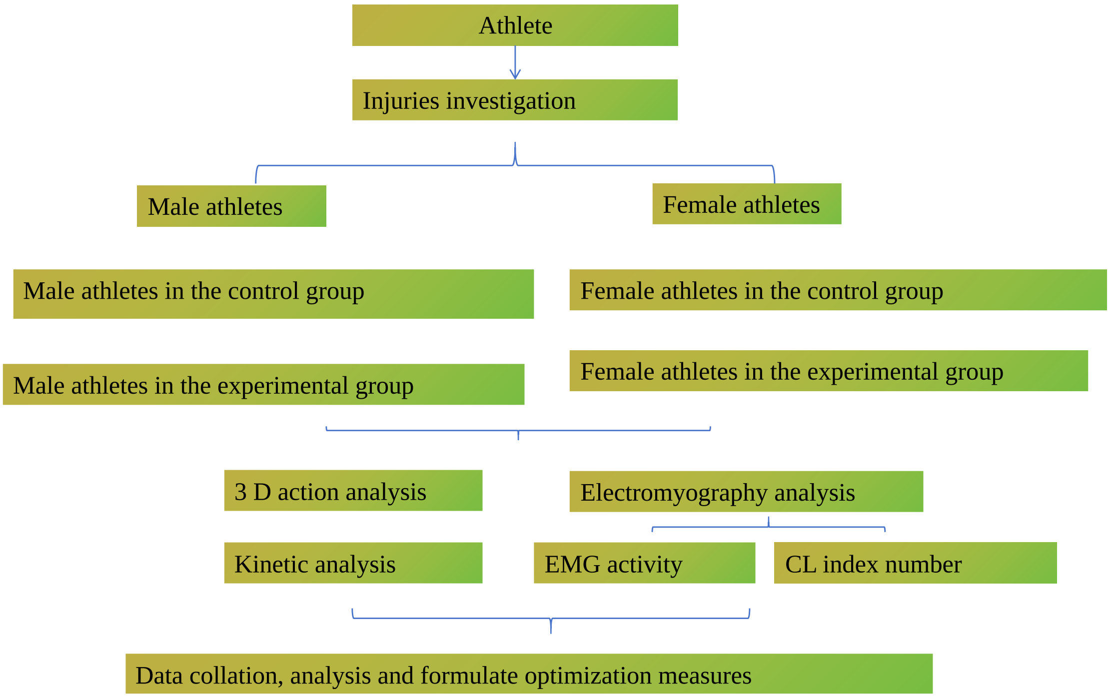

Figure 6. Research route of sports biomechanical injury in rugby players.

2.2. Results of sports biomechanical injury studies in rugby players

Table 6 shows the angle and torque data of the coronal, sagittal and frontal joints of the male, male, male, female and female experimental groups, and the greater the value indicates the greater the damage to the athletes. From the hip data, regardless of the plane, the angle and torque values in the male experimental group were generally slightly lower compared to the male control group, which means that the hip damage in the male experimental group was relatively small. However, some of the data of the female experimental group were lower than that of the female control group, but in the torque of the hip frontal plane, the female experimental group was 8.73, which was lower than the 9.14 of the female control group, indicating that the female experimental group has a lower damage in this dimension, but the difference in other aspects is not very significant.

The knee data showed that the angle and torque were lower than those in the male control group, reflecting the lower risk of knee injury in the male experimental group. In most cases, the value of the female experimental group was also lower than the torque of the female control group, such as the sagittal plane of the knee. It was 11.75, which was significantly lower than the female experimental group in the female control group, indicating that the degree of knee injury in the female experimental group was relatively mild. In the ankle joint, the data of the male experimental group were mostly lower than that of the male control group, and the injury degree was relatively lower. The female experimental group also showed a similar pattern, such as the torque of the ankle sagittal plane. The female experimental group was 11.59, which was lower than the 12.43 of the female control group, indicating that the degree of ankle injury in the female experimental group was small. In general, the angle and torque data of the experimental group in different planes of each joint were mostly lower than that of the control group, indicating that the measures used in the experiment may reduce the risk of injury of the athletes to some extent. However, there are some differences in the degree of injury, and the reasons for this difference can be further explored and how to optimize the experimental measures to more effectively reduce the degree of injury of athletes in training and competition.

Table 6. Analysis of athletes during takeoff.

		Male control group	Male experimental group	Female control group	Male control group
Hip coronal plane	angle	3.41	3.37	3.54	3.50
	moment	6.75	6.73	6.76	6.69
Hip disorganized surface	angle	8.41	8.40	8.43	8.22
	moment	6.82	6.76	6.87	6.55
Hip frontal surface	angle	8.56	8.49	8.64	8.31
	moment	9.06	8.97	9.14	8.73
Knee coronal plane	angle	12.24	12.04	12.43	11.97
	moment	13.02	12.82	13.21	12.72
Knee disorganized surface	angle	14.25	13.95	14.54	13.90
	moment	12.09	11.74	12.43	11.75
Knee frontal surface	angle	10.97	10.51	11.43	10.72
	moment	12.93	12.43	13.43	12.65
Ankle coronal plane	angle	10.81	10.19	11.43	10.64
	moment	11.77	11.10	12.45	11.64
Ankle disorganized surface	angle	13.92	13.19	14.65	13.84
	moment	11.61	10.80	12.43	11.59
Ankle frontal surface	angle	12.78	11.92	13.65	12.71
	moment	13.69	12.73	14.65	13.70

In sports training and athlete health protection, biological sports mechanics data at landing are crucial to assess the risk of injury in the athletes. By analyzing the Angle and torque data of male control group, male control group, female control group and female experimental group (the greater the value, the greater the damage), it can provide a strong basis for the adjustment of sports training strategy. **Table 7** shows the statistical table of sports biomechanical analysis when the athletes land. According to the hip data, in the coronal plane, the angle 2.73 was higher than 2.56, and the torque 6.09 was greater than 5.87, indicating that the male experimental group had a relatively higher risk of hip injury in the plane; the angle 3.50 was much larger than the female control 2.90, and the torque 6.69 was higher than 6.12, and the injury risk was more significant. In the sagittal and frontal planes, the data of the male and female experimental groups were also higher than that of the control group, indicating that the degree of injury in the experimental hip group was relatively large. For knee joint, the angle 11.25 was slightly greater than the control group 11.21, and the torque 12.02 was slightly greater than 11.98 with no difference; the female experimental group was 11.97, greater than 11.64 in the control group, and the torque 12.72 was greater than 12.41, with a slightly higher risk of injury. The sagittal male experimental group was 13.07, less than 13.13, but the torque 10.84 is less than 10.96, indicating the complicated damage in the plane; the female experimental group was 13.90, greater than 13.66 in the control group, and the torque 11.75 is greater than 11.53, and the damage risk was greater. In the frontal group, the angle was 9.60 less than 9.84, and the torque 11.32 was less than 11.58, with lower risk of injury; in the female group, 10.72, which was 10.53 greater than the control group, and the torque 12.65 was greater than 12.31, with a higher risk of injury. Ankle data showed that the angle 9.02 was 9.02 less than the control group 9.41, the torque 9.92 was less than 10.37, and the injury risk was lower; the angle was 10.64 greater than the control group, and the torque 11.64 was greater than 11.28, and the injury risk was high. The sagittal male experimental group was 12.00, less than 12.50 in the control group, and the torque 9.53 was less than 10.12, with a low risk of injury; the female experimental group was 13.84, greater than the control group, and the torque 11.59 was greater than 11.16, with a high risk of injury. In the frontal group, angle 10.64, less than the control group 11.27, torque 11.24 less than 11.98, low risk of injury; in the female group, angle 12.71, greater than the control group, torque 13.70 greater than 13.17, high risk of injury. According to the comprehensive analysis, the risk of injury in the experimental group was lower than that in the control group and less than that in the experimental group than that in the control group. This may be related to the differences in body structure, muscle strength distribution, and movement patterns between men and women. Further research of these differences, targeted training plans and protective measures.

Table 7. Analysis of the biological movement mechanics of the athletes when landing.

		Male control group	**Male experimental group**	**Female control group**	**Male control group**
Hip coronal plane	angle	2.56	2.73	2.90	3.50
	moment	5.87	6.09	6.12	6.69
Hip disorganized surface	angle	7.50	7.71	7.74	8.22
	moment	5.83	6.01	6.12	6.55
Hip frontal surface	angle	7.57	7.73	7.88	8.31
	moment	8.06	8.20	8.37	8.73
Knee coronal plane	angle	11.21	11.25	11.64	11.97
	moment	11.98	12.02	12.41	12.72
Knee disorganized surface	angle	13.13	13.07	13.66	13.90
	moment	10.96	10.84	11.53	11.75
Knee frontal surface	angle	9.84	9.60	10.53	10.72
	moment	11.58	11.32	12.31	12.65
Ankle coronal plane	angle	9.41	9.02	10.26	10.64
	moment	10.37	9.92	11.28	11.64
Ankle disorganized surface	angle	12.50	12.00	13.46	13.84
	moment	10.12	9.53	11.16	11.59
Ankle frontal surface	angle	11.27	10.64	12.37	12.71
	moment	11.98	11.24	13.17	13.70

2.3. Results of sports biomechanical injury studies in football players

Table 8 shows the statistics of sports biomechanical analysis of football players during passing. According to the data, in the hip, the male experimental group varied from the control group, but the angle and torque changes. In the knee, the plane Angle and torque of the male experimental group decreased, while the Angle of the female experimental group increased slightly and the female experimental group also increased slightly. In the ankle, the Angle and torque of each plane in the male experimental group decreased significantly, while the Angle and torque of the female experimental group increased to different degrees. Overall, male athletes showed significant reductions in knee and ankle movement amplitude after the adjustment for the exercise mechanics, meaning that male athletes have less likely injury due to excessive exercise amplitude in football. Although the range of sports in some female athletes has increased, the increase is relatively small, and combined with the characteristics of football, the overall risk of injury will not be significantly increased. So sports mechanics adjustment of the football players have a positive impact, especially the male athletes movement amplitude reduced significantly, effectively reduce the risk of injury, effectively proved that the sports mechanics adjustment to reduce the football players sports injury rate played a key role, help to keep athletes in a good physical condition in the game and training, reduce injuries.

Table 8. Statistics of sports biomechanical analysis of football players during passing.

		Male control group	**Male experimental group**	**Female control group**	**Male control group**
Hip coronal plane	angle	2.69	2.54	3.03	3.62
	moment	5.99	6.21	6.24	6.81
Hip disorganized surface	angle	7.64	7.83	7.87	8.34
	moment	5.98	6.13	6.24	6.67
Hip frontal surface	angle	7.84	7.85	8.00	8.43
	moment	8.46	8.33	8.49	8.85
Knee coronal plane	angle	11.62	11.37	11.76	12.09
	moment	12.40	12.14	12.53	12.84
Knee disorganized surface	angle	13.66	13.19	13.78	14.03
	moment	11.48	10.97	11.65	11.87
Knee frontal surface	angle	10.39	9.73	10.65	10.85
	moment	12.14	11.44	12.43	12.77
Ankle coronal plane	angle	9.99	9.14	10.38	10.76
	moment	10.99	10.04	11.40	11.77
Ankle disorganized surface	angle	13.35	12.13	13.58	13.96
	moment	11.02	9.65	11.28	11.72
Ankle frontal surface	angle	12.18	10.76	12.49	12.84
	moment	12.91	11.37	13.29	13.82

Although sports biomechanics has an important application value in the field of sports, it is not perfect, and there are some shortcomings that cannot be ignored. First, motion biomechanical research relies on all kinds of advanced measurement equipment and technologies, but these devices are prone to produce errors in the measurement process. Individual differences are a major challenge for movement biomechanics. Each person's body structure, muscle strength, exercise habits and so on are completely different, even if using sports biomechanics to develop a general training or injury prevention program, it is difficult to accurately apply to every athlete. The study of motor biomechanics is more expensive. From the purchase and maintenance of professional measurement equipment, to the recruitment of professional researchers, and then to the collection and analysis of a large amount of experimental data, all require a huge amount of money and time.

3. Conclusion

By studying the application of sports biomechanics in improving the technical level of athletes and reducing sports injury, we systematically studied the internal connection between the technical level of athletes and sports injury in sports represented by rugby and football, and found that different genders and different sports amplitude will have different effects on the muscle and joint movement amplitude of athletes. In the knee of football, the plane Angle and torque of the male experimental group decreased, while the Angle of the female experimental group increased slightly, and the torque also increased slightly. In the ankle, the Angle and torque of the female experimental group decreased significantly, while the female experimental group was lower than the female control group, but the torque of the hip in the female experimental group was 8.73, lower than the 9.14 of the female control group, indicating that the female experimental group had less damage in this dimension. So sports mechanics adjustment of the movement of football athletes have a positive impact, especially male athletes movement reduced significantly, effectively reduce the risk of injury, effectively proved the sports mechanics adjustment to reduce the football players sports injury rate played a key role, help athletes in the game and training to maintain good physical condition, reduce injuries, sports mechanics adjustment, the athletes' sports skills have improved significantly, more stable, the overall performance is better, it provides a powerful basis for athletes through the sports mechanics optimization training.

Conflict of interest: The authors declare no conflict of interest.

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