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Article

Risk assessment of competitive injuries in college basketball from a bio-mechanical perspective

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Abstract: Personal safety is of vital importance to college students in basketball competitions. Sports injuries can have a serious impact on students and may also affect the overall development of the team and personal future. Therefore, preventing and reducing injuries of college students in basketball competitions has become the primary task of universities and teams. This article analyzes the injuries of athletes in basketball by deeply understanding the eight aspects of thought, pre-match preparation, technical errors, exercise load, physical and psychological state, organizational methods, rule violations, and protective equipment. This paper constructs a linear model for predicting the probability of injury risk in college basketball sports function analysis based on the perspective of biomechanics, which involves the technical field of sports function analysis. The injury risk probability prediction model established based on 8-directional data calculates the predicted value of the player's injury risk probability to monitor the trend change of the player's physical fitness. It can provide data support for the coaching team to reasonably arrange training and competitions, and provide a basis for reducing the occurrence of injuries.

Keywords: biomechanics; basketball; special sports; risk assessment; sports injuries

1. Introduction

In a regular competitive basketball game, athletes need to get rid of their opponents or seize a favorable position by starting, stopping, changing direction, jumping, etc. in an area of 28 m long and 15 m wide within 40 min. They fight fiercely in the air and on the ground for the ball, with frequent physical contact, collisions, and strong confrontation. This requires athletes to have not only a strong body, but also good explosive power, confrontational strength, endurance, flexibility, and agility and coordination, which provide guarantees for the rational use of skills and tactics [1].

The parameter values of man-to-man defense in basketball-specific competitions are almost higher than those of zone defense. Among them, the moving distance of athletes in the higher speed range and the number of high accelerations is more significant. To put it simply, in terms of moving distance, average speed, and number of speed changes, athletes' man-to-man defense is higher than zone defense, which also means that man-to-man defense consumes more physical energy. In basketball competitions, the importance of physical fitness to players' defense cannot be ignored. Different defensive tactics correspond to different situations. According to Mansour et al. [2] players need to maintain high concentration, quick reaction ability and endurance in the game to ensure effective defense, protect their basket and help the team win the game.

2. Analysis of physical fitness data for basketball-specific competitive sports

In basketball competition, high-intensity movement only accounts for about 15% of the effective time in a game (medium intensity accounts for 50%, low intensity accounts for 35%), and it is this 15% of high-intensity movement time that carries the completion of key technical actions. It plays a vital role in the performance of players' technical and tactical abilities. At the same time, players must also have the ability to recover quickly during breaks or low-intensity exercise, so as to maintain the ability to efficiently complete repeated high-intensity exercise during the game.

Explosive power and agility: Basketball requires athletes to move, jump and turn quickly, which requires good explosive power and agility.

Coordination and balance: Athletes need to maintain good body control and balance during high-speed movement and intense jumping.

Aerobic capacity: Basketball games are long, requiring participants to have excellent aerobic capacity to maintain continuous high-intensity activities.

Muscle strength and muscle endurance: Basketball requires strength and endurance of upper limbs, lower limbs and core muscles.

Sensitivity and reaction ability: Quick take-off and switching directions require extremely strong sensitivity and reaction ability.

Explosive power, agility, aerobic capacity, muscle strength, coordination and reaction speed are the key physical fitness indicators of basketball players in special competitions.

In a match between two equally matched teams, an excellent attacking defender player will move about 6400 m throughout the entire game, with a maximum speed of 8 m per second. Ben Abdelkrim et al.'s research shows that players move once every 1.7 s on average, with all players moving an average of (1050 ± 51) times, while defenders move (1103 ± 32) times.

Forward players have a relatively large offensive and defensive range in the game. They need to move about 6000 m and make more than 100 explosive jumps in a full game, of which the number of jumps made by power forwards in confrontations accounts for about 50%.

Center players have to jump more than 100 times and run about 5500 m in a game on average, which is a huge test for the lower limb strength, body energy supply and nerve tolerance of tall people.

3. Specialized athletic injuries of college basketball players

Among the causes of sports injuries, muscle strain accounts for more than half (about 55%). When a muscle load exceeds the pressure or stress it can withstand, it will be strained. Most of the time, the muscle fibers in the muscle are performing rapid eccentric contraction. Eccentric contraction often occurs during the acceleration and deceleration phases of the movement, such as when taking off or landing in basketball. Eccentric contraction is a muscle contraction output, but the muscle length increases [3].

Players playing contact sports may suffer injuries to muscles, ligaments and joints. Injuries to these areas can severely affect their function, disrupt the player's daily life or reduce the ability to perform standard tasks. Such injuries can be divided into the following two categories:

Contact injuries occur in sports involving at least 2 players, or in team sports that involve contact or collision. Physical contact can cause injuries to muscles and ligaments because they are forced out of place or torn [4].

Non-contact injuries occur in isolated individuals and can be caused by twisting the body due to unstable movements such as jumping or falling. This can cause players to injure or tear muscles, ligaments and joints [5].

During competition, when players stretch the injured area, they reproduce the muscle strain (excessive muscle load + increased length). At this time, the already injured muscle area is stretched again, increasing the risk of the injury becoming more serious [6].

Muscle strain: refers to an injury caused by tearing of muscle fibers. This is mainly caused by players overexerting or not warming up enough. During muscle activity, due to insufficient flexibility (not fully warmed up and stretched), abnormal contraction, or poor coordination, muscle fibers are stretched, injured or even broken [7].

The following **Table 1** shows the classification of muscle strain. We can judge the degree of the patient's strain based on physical examination and the symptoms shown by the patient:

Table 1. Muscle strain grading.

Grading	Definition	Symptom	Loss of functionality
First degree strain	<5% muscle tissue damage	1. Slight swelling; 2. Slight pain when exerting muscle force; 3. Slight pain when stretching muscles; 4. Pain is usually felt several days after the injury;	1. Slight or no functional impairment; 2. No significant decrease in muscle strength;
Second degree strain	About 50% muscle tissue damage	1. Severe swelling; 2. Obvious pain when stretching muscles; 3. Obvious pain when injured;	1. Obvious functional loss (limping); 2. Obvious decrease in muscle strength;
Third degree strain	100% muscle tissue damage	1. Severe edema and pain; 2. No obvious pain when the muscles are exerting force; 3. No pain when stretching;	1. Loss of muscle function and inability to walk; 2. Significant decrease in muscle strength;

Note: because the nerves that transmit sensation to the muscle are also completely damaged, the ruptured muscle itself does not cause pain. However, when a third-degree strain occurs, the surrounding tissues (tendons, nerves) are usually also strained to the first or second degree. When the player stretches, these tissues may be pulled, causing pain.

Contusion: A contusion is a trauma caused by blunt force impact on subcutaneous tissue. It is commonly caused by collisions between athletes' limbs. It is common for micro-capillaries in the affected area to rupture and bleed, resulting in surface hematoma. The injuries are shown in the **Figure 1** below:

Figure 1. Contusion.

Sprain: A sudden and violent twisting of a joint, which twists the ligaments and tendons attached to the outside of the joint, will cause a sprain. Generally speaking, players are most likely to suffer from sprains in the ankle, knee, wrist and waist.Please see **Figure 2** for details.

Figure 2. Foot sprain.

Source: https://p-ortho.com/zh.

Ankle sprains are divided into grades.

Grade 1 sprain

The ligaments are slightly stretched but not torn.

Minor swelling and soreness around the ankle.

The diagnosis shows no instability. The patient is able to walk but has mild pain.

Grade 2 sprain

The ligaments are partially torn.

There is moderate pain, swelling and soreness around the ankle.

The diagnosis shows mild to moderate instability, limited range of motion and some loss of function. Walking or weight bearing is painful [8].

Grade 3 sprain

The ligaments are completely torn.

There is severe pain, swelling and soreness around the ankle.

The diagnosis shows significant instability and significant loss of function and range of motion. The patient may not be able to walk or bear weight.

There are three types of ligament injuries for players: the first is medial collateral ligament injury, which occurs when the lower leg suddenly rotates outward during knee flexion or extension. The second is lateral collateral ligament injury, which occurs when the lower leg rotates inward during knee flexion and extension. The third is cruciate ligament injury, which often occurs during anti-articular movements of the knee joint. Players often suffer from ligament injuries. In severe cases, you can even hear the sound of ligament rupture, and you cannot continue to exercise due to severe pain. Players will experience swelling, tenderness and effusion in the knee joint, and spasm of the knee muscles. After the player is injured, he cannot move the knee joint, and the knee joint must be kept straight or bent. There is an obvious tenderness point at the rupture of the ligament. The injury is shown in **Figure 3** below.

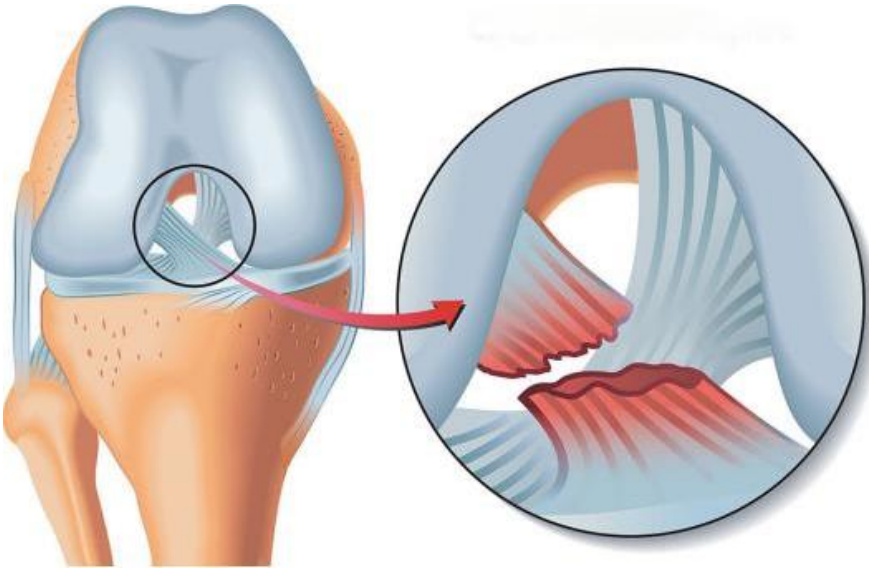

Figure 3. Cruciate ligament tear.

Source: https://virtusmedical.com/.

Anterior cruciate ligament injury is a common knee ligament injury among players during competitive sports. It is usually caused by a sudden twist or

hyperextension of the knee, a direct impact on the knee, or a sudden change of direction during sports. When the ACL is torn, the knee will make a "pop" sound. The player's injured area immediately swells and becomes difficult to bend, accompanied by joint redness, swelling, heat and pain.

4. Analysis of injuries of basketball players

Basic reasons for players injuries

1) Ideological aspects: insufficient understanding of sports injuries, insufficient attention, showing off, fear, eagerness for success, and impatience;

2) Pre-match preparation: The purpose of warm-up is to further increase the excitability of the central nervous system, enhance the functional activities of various organ systems, and make the human body transition from a relatively static state to a tense active state. Players do not do warm-up or the warm-up is insufficient, the correctness of the warm-up, the amount of warm-up, and the time between the warm-up and the formal exercise. Players' lack of warm-up or unreasonable warm-up is the first or second cause of sports injuries.

3) Technical errors: Technical errors violate the characteristics of human body structure and function and the mechanical principles of movement, causing injuries. This is the main reason for injuries in college students participating in basketball competitive activities.

4) Exercise load (especially local load): The exercise load exceeds the physiological load that the exerciser can bear, especially excessive local load, which causes injury or strain due to the accumulation of minor injuries.

5) Physical and mental state: When a player does not sleep well or rest well, is sick or injured, or is in the early stages of recovery from an injury, or when fatigued, his muscle strength, accuracy of movements and physical coordination will be significantly reduced, and his alertness and concentration will be significantly reduced. Decreased, slower response. At this time, injuries may occur when players participate in strenuous exercise or practice difficult movements.

6) Organizational methods: During training, players do not follow the principles of gradual, systematic and individual treatment, lack correct demonstration and patient and meticulous teaching, and lack protection and self-protection.

7) Actions that violate the rules: Players do not follow the rules of the game, or tease each other during training, make rough movements, commit intentional fouls, etc. This is an important cause of injuries in basketball competitive sports.

8) Protective equipment: Equipment may also cause sports injuries. The terrain characteristics of the sports venue, the floor is poorly maintained or in disrepair, the surface is not smooth or has cracks. Players lack the necessary protective equipment (such as wrist guards, ankle guards, etc.); players' clothing and shoes and socks during exercise do not meet sports hygiene requirements, etc.

Among the 188 middle school students surveyed, 132 students had different degrees of injuries during sports, with an incidence rate of 70.21%. A total of 256 people were injured in different parts of the body, with an average of 1.36 injuries per person. The highest incidence of finger injuries was 23.59%; followed by ankle joints (19.43%), knee joints (14.00%), waist and back (7.90%) and wrists (9.76%).

The most common injury type was joint sprains, accounting for 37.94%; followed by soft tissue contusions (19.87%), muscle strains (17.94%) and skin abrasions (14.26%). In addition, there were ligament tears, tooth and meniscus injuries, internal organ injuries and concussions.

The survey found that the reasons for students' injuries were: poor venues, accounting for 27.52%; improper warm-up activities (22.48%), violations of rules and technical errors (15.93% and 17.79%), etc. In addition, climate, clothing, shoes, jewelry and glasses worn by students can also cause injuries in basketball [9].

College players often encounter problems with poor sleep before major competitions, such as difficulty falling asleep, waking up too early, etc. Lack of sleep can easily lead to injuries to players! Poor sleep is mainly caused by the following reasons.

1) Physiological reasons: such as physical discomfort caused by illness, menstrual cycle, eating irritating foods such as peppers, drinking irritating beverages such as strong tea, and disrupting the regular schedule due to jet lag.

2) Environmental factors: such as high temperature, high humidity, too noisy surrounding environment, too strong light in the room, etc. Especially when going abroad for competitions, changes in living environment can easily lead to poor sleep.

3) Psychological factors: Before the game, athletes may overthink because of uncertainty about the outcome of the game, or feel that it is difficult to control the game because of lack of self-confidence, or be overly excited because of facing a major game, etc. The above factors will lead to poor sleep [10].

This model uses 8 indicators, namely, thought, pre-match preparation, technical errors, exercise load, physical and psychological state, organizational methods, rule violations, and protective equipment. The larger the values of the six indicators of technical errors, exercise load, physical and psychological state, organizational methods, rule violations, and protective equipment, the greater the risk of injury, which are type I parameters; the larger the values of the two indicators of thought and pre-match preparation, the smaller the risk of injury, which are type II parameters. The above data comes from the collection of team managers, among which thought is basic information [11].

The value of parameter j of player i is x_{ij} (i＝1,…,N; j＝1,…,M). For each parameter J, we define a reasonable range [A_j, B_j], and get

$$A_j \le x_{ij} \le B_j \tag{1}$$

A linear model for predicting injury risk in college basketball from a biomechanical perspective is constructed by the following steps:

1) Obtain injury risk prediction indicators, which include Class I indicators and Class II indicators;

2) Count the number of players i as N, i = 1, ..., N; and the number of parameters j related to injury risk prediction indicators as M, j = 1, ..., M; record the risk point X_{ij} of parameter j of player i, and obtain S_{ij}:

$$S_{ij} = \begin{cases} (x_{ij} - A_j)/(B_j - A_j) \\ (B_j - x_{ij})/(B_j - A_j) \end{cases} \tag{2}$$

Therefore, s = 0 is the minimum risk and s=1 is the maximum risk.

We use a linear model to calculate the injury risk. For each parameter, we calculate the injury risk probability of player *i* for this parameter. The formula is as follows:

$$P_{ij} = 0.1 + 0.8s_{ij}$$

The overall injury risk probability of player i, denoted as (IRP)*i*, is obtained by calculating the average value of P_{ij} ($j = 1, ..., M$):

$$(IRP)_i = \overline{P_{ij}} = \sum_{j=1}^{M} W_j P_{ij} \tag{3}$$

We give the same weight to all indicators except protective equipment, which is given double weight, so we get the following:

$$W_j = \begin{cases} 2/(M+1) \\ 1/(M+1) \end{cases} \tag{4}$$

(See **Figure 4**) The application of the linear model for predicting injury risk probability in sports function analysis in college basketball competitions.

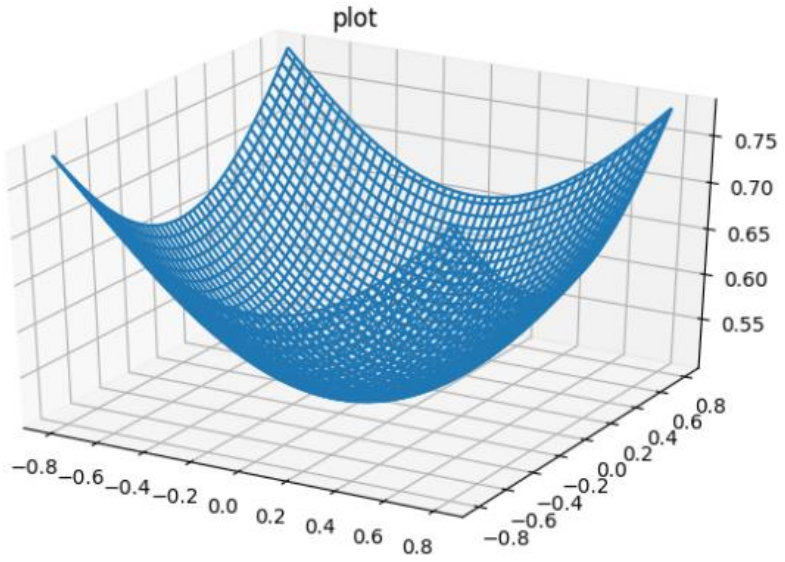

Figure 4. Model visualization images.

The linear assumption of the model and its parameters ensures that RSS is always a convex function. By solving a simple partial differential equation, the optimal parameters are obtained. This is the best solution for college players to avoid injuries in basketball competitions.

5. Preventing injuries to college students in basketball competitions

Basketball competition itself is an intense sport. Therefore, both teachers and student players have neglected warm-up activities before class. As a teacher who guides basketball teaching, you should first recognize the importance of adequate warm-up, and always convey the importance of warm-up activities to students, cultivate students to develop a good habit of warming up before basketball or other sports, and actively guide students to do adequate warm-up activities. In addition,

teachers should formulate different warm-up activities according to actual teaching content or time, climate, venue and other factors, and pay attention to the characteristics of students' physical conditions, especially the parts that are prone to injury, emphasize key activities, and strengthen self-protection.

The key to preventing basketball sports injuries for college students is to improve their self-protection awareness and follow scientific sports principles and methods. The following are some effective preventive measures:

5.1. Warm up and stretch adequately

Perform appropriate warm-up activities before competitive basketball, such as jogging, dynamic stretching, etc. This can increase muscle temperature and elasticity and reduce the risk of injury. At the same time, proper stretching after exercise can also help relieve muscle tension and prevent chronic injuries [12].

Warm up before planning to start exercise. Generally speaking, warm-up should first focus on major muscle groups, such as hamstrings. Then, if necessary, players can also do more exercises for their own sports or activities.

Initially, the player will do the activities and movement patterns of the chosen sport. However, the player will do this at a slow, gentle tempo and slowly increase the speed and intensity. This is called a dynamic warm-up. A warm-up may cause slight sweating. However, a warm-up is generally not tiring [13].

Here are some examples of warm-ups:

To warm up for brisk walking, walk slowly for 5 min to 10 min.

To warm up for running, walk briskly for 5 min to 10 min.

When actively stretching, players should use similar movements to static stretches, but instead of holding them for 30 s, they should hold them for 2 s–4 s. Active stretching is the best way to maintain the flexibility gained from static stretches without reducing the muscle's ability to produce force [14].

Dynamic stretching is an increasingly popular flexibility training method before exercise. Dynamic stretching involves using body weight to move the body through a full range of motion. This type of exercise usually targets the muscle groups that will be used in the upcoming exercise. The best dynamic stretch before a run is to do some leg swings to get the hips moving.

5.2. Choose the intensity of exercise

Aerobic exercise. Players should perform at least 250 min of moderate-intensity aerobic activity or 150 min of vigorous-intensity aerobic activity per week. They can also combine moderate-intensity and vigorous-intensity activities. Players should try to spread this amount of exercise over several days or longer in a week.

Players engage in 300 min or more of moderate-intensity aerobic activity per week. This amount of activity may help lose weight or maintain weight loss.

Moderate-intensity aerobic activity includes brisk walking, biking, swimming, or mowing the lawn. Vigorous-intensity aerobic activity includes activities such as running, swimming, heavy yard work, or aerobic dance.

Players generally must compete at a moderate or vigorous intensity level to achieve the greatest benefit. When it comes to weight loss, the more intense or

longer the activity, the more calories you burn. Excessive activity can increase the risk of soreness, injury, and burnout. Players should start with low-intensity exercise and then slowly increase to moderate or high intensity. In general, activity should be increased by about 15% each week to be safe.

5.3. Strength training

Players should perform strength training for all major muscle groups at least twice a week. Health and fitness benefits can be achieved by doing just one set of each exercise. Players should use weights and resistance levels that cause muscle fatigue after 12 to 15 repetitions [15].

Strength training may include the use of free weights, weight machines or resistance equipment, as well as activities that utilize your own body weight, such as trying squats, planks or lunges. Free weights. Barbells and dumbbells are typical strength training tools. Players can include the use of medicine balls or kettlebells.

Cable suspension training. Cable suspension training is another option to try. In cable suspension training, players suspend a part of their body, such as their legs, while performing weight exercises such as push-ups or planks.

5.4. Weight training

When players do weight training, they should pay attention to the following:

Lifting weights are appropriate. Players can start with weights that they can lift easily for 20 to 35 times.

Players can effectively increase strength by doing a set of 20 to 35 repetitions of a weight that fatigues their muscles, and the effect is the same as doing three sets of the same exercise. As players gain strength, they can gradually increase the weight.

When lifting weights, move through the full range of motion of your joints. The better your form, the better your results and the less likely you are to get injured.

5.5. Core stability training

Core strength exists in all sports and plays a stabilizing and supporting role in the body posture, sports skills and special technical movements of players in competitive sports. This is also determined by the body position and the energy stored in the muscle groups.

If the player’s body is not stable enough, he must first improve his stability before moving on to the next stage of agility training. Coach Nunez recommends starting with a standing position, then quickly changing to a single-leg balance position and holding for 3 s to 5 s, then switching legs and repeating several times. If the player is still not satisfied with his balance, he may wish to add a few more single-leg training sessions to his weekly training plan.

Since different core muscles have muscle fibers that are oriented in different directions, sufficient spinal stability or stiffness is achieved by activating antagonistic muscles on both sides of the trunk at the same time. Therefore, core stability training focuses on a variety of exercises that combine stabilizing functions (such as isometric movements) and dynamic kinetic energy (such as concentric and eccentric movements).

During the player's shooting sprint, their core stiffens, limiting trunk rotation and allowing the core muscles to maintain the pelvis in a horizontal position as much as possible. This allows the hip flexors (such as the rectus femoris) and hip extensors (such as the gluteus maximus) to work powerfully and dynamically, and the hips can transfer force through the body to the opposite shoulder, completing an efficient arm swing [16].

5.6. Sports protective gear

Arm guards: Dribbling, layups, shooting, etc. all require the cooperation of arms and elbows. Similarly, the probability of arm injuries will also increase greatly. With the existence of arm guards, the temperature of the arm and the tightness of the muscles can be maintained. The temperature ensures that the energy of the arm is not easily lost, and the tightness keeps the muscles in a state of adapting to intense exercise and is not easy to pull the arm muscles or cramps; at the same time, the players protect their elbows and ensure that the skin on the arms will not be scratched in the process of scrambling for the ball [17].

Knee pads: The knee joint is a transit station for the lower limbs and is an extremely important part in basketball special competitive sports. Because the knee joint has a long force arm and is a load-bearing joint, it is easy to cause injuries if the player's movements deviate a little. Through knee pads, pressure can reduce the damage caused by joint twisting, hyperextension and bending; through the cushioning pads of the knee pads, the impact of physical contact between players can be reduced to avoid injuries.

Ankle guards: The ankle joint is the closest weight-bearing joint to the ground, that is, the ankle joint is the joint with the most weight in the whole body. The stability of the ankle joint plays an important role in the normal progress of the player's special competitive sports.

6. Conclusion

The significance of college players participating in basketball competitions is to overcome the inertia of the physiological functions of the organs of the body, shorten the time it takes for the body to enter work, and enable the body to enter the working state as soon as possible. Players can increase the synovial fluid in the knee joint and reduce the friction inside the joint by doing sufficient warm-up exercises. The flexibility exercises in the warm-up exercises can fully stretch the soft tissues such as muscles, ligaments and tendons, increase their elasticity, make the joints more flexible, and increase the range of motion. Sufficient warm-up is one of the important guarantees for smooth teaching, training and competition. If players do not pay enough attention to warm-up, it is easy to cause injury. At the same time, players should also pay attention to the interval between warm-up and formal training or competition. If the time is too long, the effect of warm-up will be reduced or even disappear.

Stretching, warm-up and relaxation can help players reduce the chance of injury; a healthy and reasonable nutritional structure can provide players with the energy needed for high-intensity training, while meticulous physical training can

improve players' anaerobic endurance and overall physical fitness. Strength training helps players increase their strength and avoid injuries; jumping training can improve players' explosive power, allowing them to jump higher and run faster; flexibility training makes players more agile and improves their ability to change direction, thereby further improving their athletic performance. Scientific training methods and self-protection awareness are the key to ensuring that players can effectively reduce physical injuries during basketball competitions.

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Ethical approval: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Wuzhou University (16/GX/0066, 08/07/2024). Informed consent was obtained from all subjects involved in the study.

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

References

1. Antoranz Y, Sáez de Villarreal E, del Campo Vecino J, Jiménez-Saiz SL. Sure Steps: Key Strategies for Protecting Basketball Players from Injuries—A Systematic Review. Journal of Clinical Medicine. 2024 Aug 20;13(16):4912.
2. Xu K, Liu C. An investigative analysis of basketball injuries by college students. Revista Brasileira de Medicina do Esporte. 2023 Feb 9;29:e2022_0792.
3. Feingold CR. Self-Esteem, Sport Confidence and Injury in the Female Adolescent Basketball Athlete (Doctoral dissertation, California State University, Fresno).
4. Chu EC, Lin AF, Mok S, Piong SZ, Ng G. A central slip injury in a professional basketball player. Cureus. 2023 Feb;15(2).
5. Carabasa García L, Lorca-Gutiérrez R, Vicente-Mampel J, Part-Ferrer R, Fernández-Ehrling N, Ferrer-Torregrosa J. Relationship between anterior cruciate ligament injury and subtalar pronation in female basketball players: case-control study. Journal of Clinical Medicine. 2023 Dec 6;12(24):7539.
6. Ang Z. Application of IoT technology based on neural networks in basketball training motion capture and injury prevention. Preventive Medicine. 2023 Oct 1;175:107660.
7. Stojanović E, Faude O, Nikić M, Scanlan AT, Radovanović D, Jakovljević V. The incidence rate of ACL injuries and ankle sprains in basketball players: a systematic review and Meta‐Analysis. Scandinavian Journal of Medicine & Science in Sports. 2023 Jun;33(6):790-813.
8. Huang Y, Li C, Bai Z, Wang Y, Ye X, Gui Y, Lu Q. The impact of sport-specific physical fitness change patterns on lower limb non-contact injury risk in youth female basketball players: a pilot study based on field testing and machine learning. Frontiers in physiology. 2023 May 12;14:1182755.
9. Yin L, Alejandro MU, Li S. Application of multi-target positioning algorithm in basketball teaching system and injury prevention. Preventive Medicine. 2023 Aug 1;173:107612.

10. Naing NW, Aung SY. Ankle And Foot Injury-Basketball: 549. Medicine & Science in Sports & Exercise. 2024 Oct 1;56(10S):173-4.
11. Li P, Tasnaina N, Soachalerm A. Developing Injury Prevention and Rehabilitation Program Added in Basketball Class for College Students. International Journal of Sociologies and Anthropologies Science Reviews. 2023 Jun 11;3(3):251-66.
12. Chen H. Physical training applied to injury prevention in basketball. Revista Brasileira de Medicina do Esporte. 2023 Jan 30;29:e2022_0489.
13. Huafeng Shen, Zhiming Wang. Research on the characteristics of basketball and special physical training strategies. Modern Education Frontier. 2022 Jun 14;3(4):82-5.
14. Feng Jie. A brief analysis on how to prevent sports injuries in basketball games. Stationery and Sports Goods and Technology. 2015(22):146-.
15. Zhu Haiying. Investigation, analysis and prevention of common sports injuries among basketball players. Journal of Yunnan University of Finance and Economics. 2004(S1):313-6.
16. Li Donghua, & Du Chenglin. (2022). Research on the causes and prevention strategies of common sports injuries in basketball. Education World, 4(17).
17. www.sport.gov.cn/n316/n337/c944945/part/592190.pdf