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Research on Preventing Sports Injuries in Athletics Teaching Based on VR Technology

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Abstract: With the rapid development of virtual reality (VR) technology, its application in sports teaching has received extensive attention and research. VR technology creates immersive three-dimensional environments that allow students to train in simulated competitive settings, thereby enhancing learning outcomes and reducing safety risks associated with actual training. This technology increases student engagement and interest and effectively prevents sports injuries and enhances teaching safety. This study explores the application of VR technology in college track and field teaching and analyzes its effectiveness in preventing sports injuries and the challenges it faces, aiming to provide theoretical reference and insights for the research of VR technology in the field of sports teaching.

Keywords: VR Technology; Track and Field Teaching; Prevention; Sports Injuries; Immersion

1. Introduction

1.1 Research Background

High school track and field athletes have a relatively high incidence of sports injuries during training, which can lead to various types of injuries, including ligament strains, muscle strains, and joint sprains, among others. These injuries predominantly occur in areas such as the ankle, knee, hamstrings, lower back muscles, and biceps. The causes of these injuries are diverse and include insufficient muscle strength and flexibility, unscientific training organization, improper technical movements, and poor physical condition, among others [1]. These injuries not only affect the athletes' training effectiveness and competition performance but can also lead to long-term health issues, such as chronic pain and movement dysfunction.

Virtual Reality (VR) technology, as an emerging technology, achieves an immersive effect by simulating real environments or objects and presenting them to users. It plays a significant role in the advancement of modern educational informatization, especially in university physical education, where the application of VR technology has become a trend. VR technology can break through the limitations of traditional physical education in terms of space, equipment, and safety, providing scientific and accurate guidance, effectively increasing learners' enthusiasm and sports skills. Moreover, VR technology, combined with sensor technology, 3D animation technology, and network communication technology, can effectively integrate physical training with virtual reality technology, improving athletes' technical levels and training quality. The application of this technology can enhance muscle function, body control, and coordination through personalized training programs, which is particularly important for preventing and reducing the risk of sports injuries.

As an emerging educational tool, VR technology has a broad application prospect in sports training. By utilizing VR technology reasonably, it can effectively prevent and reduce the occurrence of sports injuries, while improving training efficiency and quality, providing support for the healthy growth and skill enhancement of athletes. With the advancement of technology and the reduction of costs, VR will play an even more important role in future sports education and training.

1.2 Research Significance

The importance of preventing sports injuries for enhancing the quality of track and field

teaching and athlete performance in colleges is self-evident. Firstly, sports injuries can directly affect students' physical health and safety, leading to their inability to participate in normal training and competitions, thereby affecting the overall effectiveness of teaching. Secondly, sports injuries may lead to serious mental health issues, such as depression and anxiety. Additionally, students with a history of sports injuries are more prone to developing eating disorders, which can exacerbate mental health problems. These issues may affect their learning efficiency and academic performance, thereby impacting the normal progress of physical education and training work.

Sports injuries not only pose a threat to students' physical and mental health but can also negatively influence their future career choices. In college track and field teaching, due to the complexity of technical movements and the competitive nature of the sport, the incidence of sports injuries is relatively high. Therefore, taking effective preventive measures, such as using VR technology for the prevention of sports injuries and reducing their occurrence, is crucial for ensuring teaching quality and improving athlete performance.

2. Overview and Characteristics of VR Technology

VR (Virtual Reality) technology is a technique that creates a virtual three-dimensional environment through computer systems, allowing users to immerse themselves and interact within it. VR technology has several notable characteristics. First and foremost, immersion is at its core, using various sensory stimuli such as sight, sound, and touch to provide users with an experience as if they were truly there. Secondly, interactivity enables users to naturally interact with virtual objects through gestures, movements, and voice commands, receiving immediate feedback, which enhances engagement and the accuracy of the system's response. Moreover, multi-sensory input provides users with visual, auditory, and tactile experiences, enriching their virtual experience. Presence is achieved through realistic imagery and sound effects, giving users a genuine sense of being in the virtual environment, often realized through stereoscopic and panoramic display technologies. Users have a high degree of autonomy in VR environments, able to freely explore and manipulate the virtual world, thereby enhancing a sense of control and personalized experience. The safety of VR training means users can engage in high-risk activities without the need for the real world, effectively reducing the likelihood of injury. Lastly, VR technology can stimulate users' imagination, offering new perspectives for solving complex problems and fostering innovative thinking.

3. Analysis of Types and Causes of Athletic Injuries in College Track and Field

3.1 Type of Damage

The types of sports injuries in track and field can be broadly classified into two main categories: overuse injuries and acute injuries.

3.1.1 Chronic overuse injury

Chronic overuse injuries are often associated with repetitive physical activities, particularly common in events such as long-distance running, sprinting, and middle-distance running. Common chronic overuse injuries in track and field sports include iliotibial band friction syndrome, patellofemoral pain syndrome, Achilles tendinitis, plantar fasciitis, stress fractures, chondromalacia patellae, and tibial stress fractures. The occurrence of these injuries is often related to excessive training intensity, duration, and frequency, as well as a lack of adequate rest and recovery time.

3.1.2 Acute injury

Acute injuries are typically caused by sudden external forces or improper movements, such as falls, collisions, or other forms of direct violence. Acute injuries may involve muscle strains, sprains, or other soft tissue injuries. The characteristics of acute injuries are sudden onset, significant pain, and may be accompanied by swelling and limited function. Common acute sports injuries in track and field include ankle sprains, hamstring strains, knee injuries, and low back muscle injuries. The causes of these injuries include lack of scientific training organization, poor physical condition, inadequate training levels, and poor psychological state, among others [2].

3.2 Cause Analysis

Sports injuries in track and field can be divided into two major categories: internal and external factors. Internal factors mainly include, while external factors involve training

load, training methods, and other factors.

3.2.1 Internal cause

3.2.1.1 Insufficient muscle strength and flexibility

Firstly, insufficient muscle strength can lead to an inability to effectively support the body during high-speed or high-intensity track and field activities, thereby increasing the risk of injury.

Secondly, insufficient muscle flexibility can result in stiff movements during sports, making it difficult to make rapid and accurate adjustments, thus increasing the likelihood of injury. For example, "weak links" in sports are often caused by imbalances in muscle strength, fatigue, and injuries to the body's links. Such imbalances and inflexibility can lead to compensatory movements by athletes during sports, which may be unstable and prone to causing harm.

In addition, insufficient muscle strength and flexibility can also affect an athlete's overall biomechanical performance. For instance, insufficient muscle strength can impact the propulsion of the lower limbs and the transmission of ground reaction forces, which is particularly important in events like running. When muscle activity is maximized, impact forces are mainly concentrated on areas such as the ankle and lower leg. If the muscles in these areas are not strong enough, they will not be able to effectively withstand these forces, thereby increasing the risk of chronic injuries.

3.2.1.2 Body structure and function

In track and field sports, sports injuries mainly involve multiple aspects of body structure and function. First, from the perspective of anatomy and biomechanics, the lower limbs are the parts that bear the greatest impact and load, especially during running when the foot makes contact with the ground. For example, the Achilles tendon, ankle, calf, and patellar tendon are subjected to tremendous forces during running, and if these forces exceed the tissue's capacity, they can lead to injuries [3]. Additionally, the function of muscles and bones plays a critical role in either preventing or causing injuries. For instance, an imbalance in the strength of the quadriceps and hamstrings can lead to knee instability, increasing the risk of injury. Similarly, an increase in the abduction torque of the hip and knee can also increase the risk of sports injuries [4].

3.2.1.3 Psychological stress

Firstly, psychological stress can increase the risk of injury by affecting an athlete's physiological and behavioral responses. For example, high psychological stress may lead to overexertion during training and competition, thereby increasing the load on the musculoskeletal system and the likelihood of injury. Secondly, psychological stress may also indirectly increase the risk of injury by affecting an athlete's lifestyle and dietary habits.

For instance, among female athletes, irregular menstruation, low body weight, and low fat intake are significant risk factors for stress fractures. These factors may be associated with high psychological stress, as psychological stress can affect appetite and sleep patterns, which in turn impact weight and nutritional status, thus increasing the risk of sports injuries.

From a biomechanical perspective, psychological stress can affect an athlete's movement patterns and gait, thereby increasing stress and load on certain body parts, which is particularly evident in long-distance running and other sports that require repetitive movements. For example, athletes with a history of stress fractures experience greater pressure on the forefoot and medial arch during running and jumping.

In summary, there is a complex interaction between psychological stress and injury risk in track and field sports. Psychological stress can increase the risk of injury through various mechanisms, including physiological and behavioral factors.

3.2.1.4 Personality traits and motivations

The mechanism by which personality traits and motivation contribute to the occurrence of injuries in track and field sports includes psychological and physiological factors. From a psychological perspective, personality traits such as extraversion and sensitivity are related to the risk of sports injuries. Extraverted athletes might overlook safety measures due to overconfidence, while sensitive athletes might engage in avoidance behaviors due to a high sensitivity to pain and risk. Furthermore, personality traits also affect how athletes respond to stress, with athletes who frequently get injured being more prone to feeling stressed than those who rarely get injured [5]. Additionally, from the perspective of

motivation, an athlete's attitude is also related to the risk of injury, with a positive training attitude helping to reduce the risk of injury, whereas a negative attitude can increase the risk.

3.2.2 External factors

3.2.2.1 Training load and methods

In the track and field training at colleges and universities, due to incorrect training methods, lack of scientific and reasonable training means and techniques, some common training injuries occur, such as muscle strains, joint sprains, etc. In addition, excessive training loads or sudden increases or decreases in training loads (such as changes in speed, distance, and frequency) can also increase the risk of injury to some extent. In traditional physical education, there are still many irrationalities in the intensity and volume of track and field training. Since the track and field training at schools is non-professional, and the majority of the trainees are students, there are many gaps between their physical endurance and that of professional athletes. This factor can lead to injuries due to excessively high training intensity and volume [6].

3.2.2.2 Venue and equipment issues

In track and field instruction, the occurrence of sports injuries is closely related to issues with the facilities and equipment. Unreasonable field conditions are a significant factor contributing to sports injuries. For example, the hardness, levelness, and drainage of the ground not only affect the performance of athletes but can also directly lead to injuries. If the track or training field is too hard or uneven, athletes are prone to sprains or contusions in areas such as the ankles and knees when performing jumps, running, and other movements. Additionally, the quality and maintenance of equipment are important factors influencing sports injuries. Substandard sports equipment, such as unclear markings on the track or using a long jump pit that does not meet standards, can increase the risk of athletes getting hurt. Moreover, improper maintenance of equipment, like cracks in the track that are not promptly repaired, can also increase the likelihood of injuries during use.

3.2.2.3 Environmental factors

Extreme temperatures, whether too hot or too cold, and changes in humidity can affect athletes' performance and health, thereby increasing the risk of injury. In hot environments, athletes may experience dehydration and heatstroke, while in cold environments, they may suffer from muscle stiffness and joint pain. Additionally, adverse weather conditions such as rainy days or strong winds can impair athletes' vision and hearing, thus increasing the unsafe factors during training.

3.2.2.4 Teacher and organizational factors

Physical education teachers need to possess a high level of professional competence in order to make appropriate emergency responses to different situations, helping students reduce the occurrence of injury accidents [7]. However, some studies have found that physical education teachers neglect the dissemination of preventive knowledge and lack effective warm-up guidance before training, which can lead to bodily injuries during teaching and training [8]. At the same time, unreasonable arrangements of teaching content sequence, improper scheduling of track and field classes in terms of time and organization methods, and insufficient supervision of students can all contribute to the occurrence of sports injuries.

Furthermore, each student's physical condition, athletic ability, and psychological resilience are different. If training plans are applied uniformly without considering individual differences among students, it may lead to injuries for some due to excessive training intensity or inappropriate methods. For example, for students with weaker physical fitness, excessively high training intensity not only fails to improve their athletic performance but may also result in muscle strains or other types of injuries due to overtraining.

4. The Study of VR Technology Applied in Track and Field Teaching to Prevent Sports Injuries

4.1 Simulated Training and Motion Analysis

VR technology can simulate real movement environments, including weather and track layouts, helping students become familiar with various track and field events, reducing accidental injuries caused by unfamiliarity. At the same time, it precisely captures and provides feedback on students' sports

movements, analyzing the captured motion trajectories and using a feedback system to help students correct incorrect movements. This technology not only improves the efficiency of students learning technical movements but also reduces sports injuries caused by incorrect actions, thereby providing scientific and accurate guidance for learners. For example, VR can simulate complex movements such as starting, accelerating, and jumping, allowing students to practice repeatedly without actual risk, effectively improving sports skills while reducing the risk of injury [9].

4.2 Virtual Simulation Experiment

Virtual reality technology can be utilized for comprehensive interactive experimental projects involving self-prevention of common injuries in track and field sports and on-site first aid. This not only enhances students' engagement and interest but also effectively trains them to recognize and respond to these situations through simulating real or hypothetical sports injury scenarios. Implementing this approach helps improve the safety and efficiency of track and field sports, reducing the occurrence of sports injuries [10].

4.3 Provide an Immersive Experience

VR technology can be used not only for training basic skills but also for creating immersive learning environments that allow students to learn as if they were actually there, increasing the fun of the training, enhancing student engagement and motivation. This immersive learning experience helps students better master motor skills, perform better in actual sports, and reduce the likelihood of injuries [9].

4.4 Provide Personalized Training Plans.

VR technology can also provide personalized training programs based on each student's physical condition and skill level, as well as adjust the intensity and content of the training. This method of personalized training can effectively prevent sports injuries caused by overtraining and inappropriate training intensity.

4.5 The Mastery of Motor Theory and Skill Transfer

By combining theoretical knowledge with VR technology, students can understand complex sports theories more intuitively and deepen their understanding and memory through practice [9]. This learning method, which integrates visualization and interactivity, helps students better master sports skills, thereby reducing errors and injuries in actual operations. At the same time, through VR technology, students can repeatedly practice track and field skills in a virtual environment. This repetitive practice facilitates the transfer and application of knowledge and skills. When students apply these skills to real-world track and field activities, they already possess a high level of skill, thus reducing unnecessary sports injuries.

4.6 Psychological Intervention

VR can also be used for psychological intervention, by creating a fully immersive environment that makes users feel as if they are truly in a certain scenario. This sense of immersion can greatly reduce external distractions, helping users focus on the current activity or task, thereby alleviating anxiety and stress [11]. In VR training systems, athletes can train in simulated high-pressure situations, which positively affects their ability to adapt and overcome stress and anxiety in actual competitions [11]. At the same time, through relaxation exercises and psychological counseling in virtual reality environments, students can cope with stress more effectively, thereby reducing sports injuries caused by psychological factors.

5. Challenges and Difficulties in Applying VR Technology in Track and Field Teaching to Prevent Sports Injuries

5.1 Technology Maturity and Equipment Cost

Currently, there is relatively little research on the use of VR technology in preventing sports injuries in track and field instruction. Although some studies suggest that VR can enhance the immersion and engagement of training, these studies mainly focus on other sports or training fields. Additionally, due to the immaturity of the technology and the high cost of related equipment, its widespread adoption in physical education is still restricted, which may lead to schools struggling to afford the initial investment in introducing VR technology.

5.2 User Adaptability and Acceptance

Although VR technology can provide immersive learning experiences, the adaptability and acceptance of users remain a challenge. The use of VR technology may cause discomfort to users, such as Simulator Sickness, which is a condition similar to motion sickness caused by high-fidelity visual simulators, characterized by symptoms such as nausea, eye fatigue, and disorientation [12,13]. These symptoms not only affect the user's experience but can also negatively impact the effectiveness of training, thereby affecting user acceptance and willingness for long-term use.

5.3 Safety and Comfort Issues

VR technology provides an immersive experience, greatly enhancing the engagement and interest of learners. However, this high level of immersion can also lead to a weakened perception of the real-world space, thereby increasing the risk of collisions with real-world objects. At the same time, VR equipment requires a relatively enclosed and obstacle-free space to ensure that the user's activities are not disrupted by real-world objects. If the user moves, twists, or dodges in the virtual environment while there are other obstacles or items around, it may lead to collisions and injuries.

Current VR headsets are usually sealed tightly to reduce light leakage, which makes them non-breathable, and the weight and pressure of the headsets are severe. Wearing them for a long time can cause the inside of the headset to become stuffy, leading to visual fatigue and increased discomfort in the body, especially in the neck. This not only affects the user's experience but can also affect the user's attention and reaction ability, increasing the risk of injury. Moreover, sharing equipment among multiple users can lead to the transmission of eye diseases and skin diseases on the face [14].

Additionally, the latency and input/output lag issues of VR systems can also affect the user's comfort and experience. If the system's response is not timely enough, the user's actions in the virtual environment may lead to a delay in actual movements, thereby increasing the likelihood of injury [14].

5.4 Implementation of Personalized Training

To achieve personalized training, it is necessary to accurately collect and analyze each student's motion data, including range of motion, speed, strength, etc. However, the current level of technology still has certain limitations in data collection and processing, which may affect the evaluation and adjustment of training effectiveness [15]. Moreover, although VR technology can provide highly personalized training experiences, learners' adaptability and preferences for the technology can vary greatly. Designing effective personalized training plans not only requires consideration of technical factors but also an understanding of learners' personal backgrounds, preferences, and learning styles, thus, there are certain challenges in the realization of personalized training.

6. Conclusion

High school track and field sports injuries are a widespread issue, affecting athletes' training and health. There are many reasons for sports injuries, including physical structure and function, psychological stress, environmental factors, teachers, and organizational factors. VR technology, by creating immersive three-dimensional environments, not only improves students' learning outcomes and engagement but can also effectively prevent sports injuries, ensuring the health and safety of students.

VR technology has significant advantages in track and field teaching, breaking through the limitations of traditional teaching, effectively improving training efficiency, enhancing athletes' psychological quality and training motivation, and reducing the risk of sports injuries. By collecting and analyzing users' sports data, VR systems can intelligently adjust training intensity and content, providing personalized training programs and guidance, improving their technical level and training quality, thereby effectively preventing sports injuries.

However, VR technology also faces challenges in practical applications, such as technological maturity, cost, and user adaptability. Despite this, with the advancement of technology and the reduction of costs, VR will play a more important role in sports education and training. In the future, VR technology is expected to

play a greater role in education and training, becoming an important driving force for educational innovation and reform.

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