

Research progress in the biomechanics of dart throwing

Chengtao Jiang^{1,a,*}

¹ School of Physical Education Science, Lingnan Normal University, Zhanjiang, Guangdong Province, 524048, China

^aJCT123691@lingnan.edu.cn

*Corresponding author

Abstract: In order to promote the development of darts in China, based on the basic research of darts and darts biomechanics at home and abroad, this paper analyzes the current research status of darts biomechanics at home and abroad, examines the problems and challenges encountered in the development of darts in China, and compares the differences in the development of darts biomechanics in this direction in China. It provides useful reference and enlightenment for the further research in this field, and also provides more detailed theoretical guidance for the training practice of darts.

Keywords: Darts; Throw; Sports Biomechanics

1. Introduction

Darts originated in England at the end of the 19th century as a bar game, but has evolved into a global competitive sport, which is loved for its accuracy, stability and psychological quality, and has a complete tournament system and professional players. [3] The study of sports biomechanics in this sport is very important, because it explores the complex mechanical principles behind the seemingly simple throwing motion, such as power generation and transmission, body coordination, proprioceptive integration, etc. Research on darts can help us to better understand and understand this sport, so as to promote its development and improve people's physical and mental health^[1].

The purpose of studying darts biomechanics is to improve the skill level and accuracy of darts players, and also to promote the development of sports science. Firstly, through the study of darts biomechanics, athletes can have a deeper understanding of the movement trajectory and throwing skills of darts. This can help athletes better grasp key factors such as the power, Angle and speed of throwing darts, thus improving the accuracy and stability of throwing. Secondly, the study of darts biomechanics can provide useful reference for the development of sports science. Darts involves many disciplines such as aerodynamics and sports biomechanics. The research on darts biomechanics^[2] can further promote the development and integration of these disciplines. Finally, the study of darts biomechanics can also provide useful inspiration and reference for other sports training and technical improvement. To sum up, the study of darts sports biomechanics has important practical significance and theoretical value, which can not only improve the technical level of athletes, but also provide useful reference for the development of sports science. The purpose of studying darts biomechanics is to improve the skill level and accuracy of darts players, and also to promote the development of sports science. Firstly, through the study of darts biomechanics, athletes can have a deeper understanding of the movement trajectory and throwing skills of darts. This can help athletes better grasp key factors such as the power, Angle and speed of throwing darts, thus improving the accuracy and stability of throwing. Secondly, the study of darts biomechanics can provide useful reference for the development of sports science. Darts involves many disciplines such as aerodynamics and sports biomechanics. The research on darts biomechanics can further promote the development and integration of these disciplines. Finally, the study of darts biomechanics can also provide useful inspiration and reference for other sports training and technical improvement. To sum up, the study of darts sports biomechanics has important practical significance and theoretical value, which can not only improve the technical level of athletes, but also provide useful reference for the development of sports science.

2. Basic theory of darts biomechanics

The basic theory of darts biomechanics includes the biomechanical analysis of darts throwing motion and the biomechanical factors of darts throwing accuracy^[3].

2.1. Biomechanical analysis of dart throwing motion

Motion breakdown and description: Dart throwing is a typical continuous and precise sequence of motions, starting with steady foot support, generating torque through torso rotation, then through the power transmission system of the upper limbs, and finally reaching the fine-tuning control of the wrist and fingers. The specific can be subdivided into standing posture, pre-stretching stage, aiming and pushing stage, release and swing stage. Each stage involves a series of complex and precise biomechanical changes.

Power transfer chain analysis: From lower limbs to upper limbs, legs, hips, torso, shoulders, elbows, wrists and fingers form a complete power transfer chain. The legs provide stable base support, the rotation of the hips and torso provides initial kinetic energy for the throw, and the shoulders, elbows, and wrists provide precise guidance and alignment.

Key biomechanical parameters: The holding and releasing skills of the dart are the key actions that determine the accuracy of throwing. Researchers will focus on kinematics, dynamics, and surface electromyography. The kinematic index is used to study the biomechanical parameters such as angular velocity, angular acceleration and acceleration. Dynamics study the point of force, moment and so on; Surface electromyography is also an important index to reflect the quality of throwing motion.

2.2. Study on biomechanical factors affecting dart throwing accuracy

Muscle strength: Different muscle groups play their own unique roles in dart throwing. Balance between the inner and outer rotators of the forearm is essential to keep the dart flying straight; Stabilising muscles in the back and shoulders ensure that the power is transmitted effectively during the throw without going off target. In addition, the explosive and persistent muscle power also affects the stability and consistency of dart throwing.

Joint flexibility: The throwing action of darts is mainly in the upper limbs, and the range of motion and stability of wrist, elbow and shoulder joints directly affect the accuracy and stability of throwing action. Proper wrist back extension enhances control over the release of the dart, while good elbow and shoulder stability helps maintain the correct position and orientation of the upper limb during the throw.

Proprioception: Athletes need to accurately lock on to the target through the visual system, and accurately perceive the spatial position of the arm and the dart through proprioception, so as to adjust the Angle and force of the throw. This spatial perception and motion control ability determine to a large extent whether the dart can accurately hit the bull's eye.

Neuroregulatory mechanisms: Psychological stress, concentration, motor memory, and the ability of rapid adaptation and feedback of the neuromuscular system also play an important role in the accuracy of dart throwing. A high level of concentration helps athletes eliminate distractions during a game and execute predetermined technical moves with precision.

3. Research progress of darts biomechanics

3.1. Current situation of darts biomechanics abroad

The research on darts biomechanics has been more in-depth in foreign countries, including experiment and computer simulation. The research results provide valuable reference for athletes to improve throwing accuracy and technical level. Darts biomechanics has been widely studied and paid attention to abroad^[4].

Sports biomechanics also plays an important role in darts. Aerodynamics plays an important role in darts, involving both drag and lift. The athlete's throwing skill is also an important factor that affects the dart movement trajectory.

In addition, sports biomechanics also plays an important role in darts. Muscle contraction and relaxation activities can affect the bone around the joint to produce a variety of displacement, the force

generated during muscle contraction can be used as a mechanical energy output device. Athletes need to master professional throwing skills, such as the correct way of holding, shoulder, wrist and arm coordination and force and dynamic changes in the throwing process.

3.2. Darts biomechanics in China

In China, darts biomechanics research is still relatively few, lack of systematic and in-depth research. The domestic research on darts biomechanics mainly focuses on the fields of sports biomechanics and sports engineering, including the structure of darts, throwing skills and competition rules, etc., while the research on the darts biomechanical characteristics and human body force mechanism are relatively few.

Problems in Chinese darts research. First, the domestic darts venues and facilities are relatively insufficient. Second, there are still some problems in domestic darts, such as low technical level and lack of professional talents. Third, the lack of professional darts coaches and training systems in China also limits the development and popularity of darts in the country.

3.3. Present situation of biomechanics research on throwing technology

The current situation of biomechanics research of throwing events shows the development trend of both depth and breadth, which is embodied in the following aspects; With the progress of science and technology, the biomechanics research of throwing events is deepening, which provides strong support for athletes to improve performance, reduce injury risk and scientific coaching.

Pointed out that the biomechanical research on discus, javelin, shot put and other track and field throwing events has been quite in-depth. Through three-dimensional motion capture technology, high-speed photography, dynamic model construction and other methods, the body mechanical characteristics, force conduction path and energy conversion efficiency of each stage of throwing movement were analyzed. The aim is to optimize the technical movement and improve the throwing distance^[5].

In injury prevention and rehabilitation studies^[6], researchers have been exploring the biomechanical mechanism of common injuries in throwing sports (such as rotator cuff injury and elbow overuse syndrome, etc.), looking for preventive measures and technical improvement programs from the perspective of reducing sports injuries, and also involving biomechanical principles guidance for rehabilitation training. By comparing individual differences and technical styles^[7], the throwing technical characteristics of elite athletes from different countries and regions have been widely studied. Through comparative analysis, the successful technical elements of world-class athletes are identified, and the optimal throwing strategies suitable for individuals are discussed in combination with the characteristics of different athletes' body types and power distribution. In terms of the design and improvement of throwing equipment^[8], physical research also extends to the level of sports equipment, such as how the aerodynamic characteristics and holding methods of discus and javelin affect the throwing effect. Through experimental testing and simulation analysis, the equipment design is more in line with ergonomic and aerodynamic principles. As for quantitative evaluation and training monitoring of throwing class, many advanced training centers use biomechanical evaluation system to monitor athletes' training status in real time, and reflect the quality of technical movements through quantitative indicators, so that the coaching team can adjust the training plan in time and achieve accurate training; In the direction of application research of new technologies^[9], modern scientific and technological means, such as artificial intelligence, virtual reality and augmented reality, are used to simulate throwing movements and predict movement trajectory, so as to provide athletes with immersive training experience and further improve training effects.

4. Development trend of darts at home and abroad

4.1. Development status of darts at home and abroad

Darts has developed extensively around the world, especially in some countries and regions where it has become a very popular sport^[10].

Domestically, the sport of darts has gradually become popular in China, and more and more darts clubs and competitions have begun to emerge. These clubs and competitions provide a platform for darts enthusiasts to communicate and compete, and also promote the development of darts in China; With the popularity of the Internet, more and more Chinese darts fans have begun to compete and communicate

through online platforms. This makes the influence of Chinese darts gradually expand, but also attract more young people to join the sport; Darts events in China have also gradually increased, and some international competitions have begun to be held in China.

In foreign countries, the development of darts in the world is more and more extensive, and many countries and regions have begun to pay attention to this sport. Some international darts competitions have also begun to emerge, attracting darts enthusiasts from all over the world to participate; The international recognition of darts is also increasing, and some international sports organizations have begun to consider incorporating it into official sports competitions. This will further promote the popularity and development of darts on a global scale; More and more attention is paid to the scientific research of darts. Some scientific research institutions have begun to conduct in-depth research on darts techniques, training methods and its impact on physical and mental health, which will help to better understand darts and provide better suggestions for its development.

4.2. The construction and development of darts courses in Chinese universities

Chinese university darts course construction is in the rapid development stage, the curriculum is increasingly rich, the supporting facilities are constantly improved, the competition activities are active, and the talent training also shows a positive trend. With the further promotion of darts in China, university darts courses are expected to achieve higher quality and wider coverage in the future. Since 2015, darts Club courses have been set up in universities in Central and southern China and incorporated into the sports elective course system, with a considerable number of students participating in each semester, which reflects that darts has gradually received attention in the stage of higher education and has been accepted by teachers and students. With the national attention to darts, some universities have established a darts sports association and set up a darts sports skills training center, indicating that the university level not only has an action in the curriculum, but also has invested in hardware facilities and coaching team construction.

The increasingly mature competition system promotes the development of the darts league, and the national darts competition has shown a remarkable maturity in recent years, its scale has been expanding, the number of participating teams has been increasing, forming a complete structure, extensive coverage and increasing influence of the competition system. As an important competitive stage for the national college students darts sport, it not only attracts the active participation of many domestic universities, but also shows diversified characteristics in regional coverage. From the sub-competitions in different regions such as South China and Central China to the finals, it brings together university teams from all over the country. This fully demonstrates the wide popularity and deep development of darts in college campuses across the country. In addition to the growth in the size of the competition, the organizational form of the event has also evolved with The Times, successfully integrating the online and offline competition mode.

In recent years, the construction of darts teaching team has achieved remarkable results, and some universities support the development of darts and invest more funds. On the one hand, the school provides the necessary training facilities, financial support and professional coaching guidance for the darts team to ensure that the players can continuously improve their skills in a good environment; On the other hand, by holding school trials and setting up darts courses, we can stimulate students' interest in darts and provide fresh blood for the school team. This all-round support system not only promotes the continuous improvement of the competitive level of the school team, but also promotes the popularization and participation of darts across the school.

4.3. Comparison of biomechanics development of darts at home and abroad

The research of darts biomechanics in China is relatively late. In recent years, with the popularity of darts in China and the improvement of sports scientific research level, the research in related fields has also begun to start and develop, and gradually shifted from the introduction of foreign advanced concepts and technologies to the integration of localization research and practice. In China, some sports universities and scientific research institutions have begun to get involved in the field of darts biomechanics, and carried out some preliminary research work to explore the biomechanical parameters and training modes suitable for the characteristics of Chinese darts players.

Foreign darts sports biomechanics research is relatively mature, involving technical analysis including three-dimensional motion capture, force distribution, muscle activation sequence, balance control, precise aiming mechanism, etc. Through detailed analysis of the movements of top professional

players, the researchers explored the biomechanical factors that affect the accuracy and stability of darts, and proposed improved techniques and training methods. In the world, high-precision motion capture systems, electromyography, force tables and other advanced equipment are widely used for experimental research and data analysis. Western countries, especially the United Kingdom, have a profound accumulation in the scientific research of darts, formed a relatively perfect theoretical system, and made contributions to the scientific training and competition rules of the global darts.

5. Problems and challenges in the development of darts biomechanics in China

Weak research foundation: Due to the late start of darts in China, the corresponding biomechanical research foundation is relatively weak, lack of long-term systematic research accumulation and a large number of empirical data support.

Insufficient technical equipment: Advanced motion capture systems, myoelectric analysis equipment, force sensors and other high-tech instruments are required for high-level biomechanical analysis, and the popularity and use of these devices in the field of sports scientific research in China may not be high enough.

Professional shortage: There are relatively few interdisciplinary researchers with expertise in sports biomechanics and familiarity with the characteristics of darts, which poses a human resource challenge for conducting in-depth studies.

Theory is disconnected from practice: How to effectively translate the research results into the actual training instruction scheme of the athletes and ensure that the theoretical research can actually help improve the competitive level of the darts players is a key issue.

Research investment and support: Because darts sport compared with other mainstream sports, there may be a gap in social awareness and attention, resulting in its scientific research investment and support may be relatively small.

6. Conclusions

The development of darts biomechanics in China needs to overcome many problems, including strengthening the construction of basic research facilities, training specialized talents, increasing scientific research investment, strengthening the combination of theory and practice, so as to promote the rapid and healthy development of this field.

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