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Epidemiological Characteristics and Injury Mechanisms of Taekwondo-Related Injuries: A Systematic Review

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Abstract

As a highly-combative Olympic sport, taekwondo has one of the highest injury-incidence rates among Olympic disciplines, yet its epidemiological characteristics and injury patterns remain unclear. This study performed the-first-ever systematic analysis of the epidemiological features and injury mechanisms of taekwondo. A systematic search identified 552 publications published between 2000 and 2024, among which 24 studies covering 15,170 athletes met the inclusion criteria. Results demonstrated that lower-extremity injuries accounted for the largest proportion (54.3%), with the ankle/foot, knee and face being the most-frequently injured sites. Contusions, sprains and strains were the predominant injury types. The injury risk was markedly higher in the third round than in the first two rounds, while the first round carried the lowest risk, a trend associated with fatigue accumulation and aggressive tactics. Major contributing factors to injuries included inattention, unsatisfactory venue facilities, improper use of protective equipment, rule revisions, high-difficulty techniques and insufficient physical conditioning. It is recommended to implement the International Olympic Committee Injury Surveillance System (IOC-ISS) for standardized injury monitoring, together with improvements in protective-gear technology and rule optimization. Future research should prioritize biomechanical analysis of taekwondo movements, long-term follow-up of chronic injuries, and the establishment of an integrated system combining prevention, surveillance and rehabilitation.

Keywords

Taekwondo; Sports injuries; Epidemiology; Injury mechanisms.

1. Introduction

Taekwondo, one of several fighting events in the modern Olympic Games[1], originated in North Korea and is mainly characterized by unarmed combat. As an Olympic event, Taekwondo's competition rules allow full contact kicks to the head and torso, as well as punching the front of the torso. Because of its fiercely confrontational nature, Taekwondo not only demonstrates a combination of technique and strength, but also brings a high risk of sports injuries. Of the 32 events in the Summer Olympics, the incidence of sports injuries in Taekwondo ranked second in Beijing 2008[2], first in London 2012[3], and fourth in Rio 2016[4]. In order to reduce the incidence of injuries, the International Olympic Committee (IOC) has carried out a series of sports injury epidemiological studies, analyzing the risk factors and mechanisms for the occurrence of injuries and diseases in various international competitions, including the Olympic Games[5]. The injury and illness surveillance foam, which is currently used worldwide, was approved by the International Olympic Committee Medical Committee, first launched in the 2004 Athens Olympic Games, and further improved in the 2008 Beijing Olympic Games, and is suitable for individual and team sports[2].

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A recent review from abroad indicates that 283 athletes recorded 1466 injuries, with an average of 4.6 injuries per athlete per year [6]. These data show that the injury risk of taekwondo athletes is at a high level over the long term. There is still a lack of epidemiological research on Taekwondo sports injuries in China, and although there are epidemiological studies on Taekwondo injuries abroad, there is a lack of in-depth discussion on the injury mechanism and prevention strategies[6–8]. Therefore, this study systematically combed through: (1) the epidemiological characteristics of taekwondo injuries; (2) Cause and mechanism of injury in Taekwondo. This study is expected to provide scientific basis for reducing the incidence of sports injury in Taekwondo, and provide reference for injury prevention and management strategies, which has important clinical application value and wide social significance.

2. Research Methods

Through computer searching Google Scholar, PubMed, Web of Science, Scopus, CNKI and other search platforms, the relevant literature on Taekwondo sports injury and epidemiology was searched from January 1, 2000 to July 1, 2025. The English keywords are: "taekwondo", "taekwondo injury", "epidemic", "damage", "rehabilitation*", "prevent", etc.; The Chinese keywords were: Taekwondo injury, epidemiology, rehabilitation, prevention and so on. Keywords are retrieved by combining free words and subject words. Abstracts, conferences, grey references, etc. did not meet the criteria for literature inclusion. After independent evaluation by two reviewers, reading the title, abstract and full text, it was finally determined that 24 literature items were included in the standard, including 6 items from China, 5 items from South Korea, 2 items from the world, Australia, Canada and Germany, and 1 item from Portugal, Spain, Iran, Greece and Sri Lanka. A total of 15,170 athletes were counted, and the types of taekwondo athletes involved included professional athletes, club athletes and amateur athletes.

3. Research Results

3.1. Analysis of epidemiological characteristics of Taekwondo sports injuries at home and abroad

3.1.1. Incidence of Injury

The incidence of injury is usually expressed as rate/1000AE (number or proportion of sports injuries per 1000 athlete Exposure), rate/1000ME (Minutes Exposure number or proportion of sports injuries per 1000 Minutes of athlete Exposure), and rate/100 athletes (number or proportion of sports injuries per 100 athletes), as detailed in Table 1. Among them, athlete exposure (AE) refers to the frequency of athletes participating in competitions or training, usually calculated per 1000 exposures; Minute exposure (ME) refers to the time an athlete actually participates in a competition or training, calculated per 1000 minutes of exposure.

The injury rates were divided into competition and training categories, and a total of 16 studies reported the sports injury rates of 8,998 taekwondo athletes on different occasions. The results showed that 78.3 (24.86-220.3) /1000AE was significantly higher for competition than 4.79/1000AE for training in the rate/1000AE indicator, indicating that injuries occurred more during competition in the same number of exposures, possibly associated with high intensity at the time of competition; In the rate/1000ME indicator, race 35.6 (7.63-94.98) /1000ME was significantly higher than training 8.6 (2.15-15) /1000ME, indicating that injuries occurred more in the race during the same exposure time; In the rate/100 athletes index, the training injury rate of 90.8 (79.4-97.3) /100 athletes was significantly higher than that of 16.35 (5.97-33.08) /100 athletes; It may be that the training exposure time is much longer than the game exposure time, resulting in more injuries accumulated in training.

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3.1.2. Injury site

A total of 18 studies reported data on injury sites in taekwondo athletes, without distinguishing between competition, training, gender and age. The results showed that the injury rates of different injury sites from high to low were: (1) divided by large areas: lower limbs 54.3% (29%-76.5%), upper limbs 17.6% (6.45%-43.0%), trunk 10.2% (4.1%-22.5%), head and neck 9.8% (0.6%-23.2%); (2) By small area: ankle/foot 27.1% (8.8%-42.3%), knee 21.1% (8.4%-58.1%), face 14.2% (1.2%-29.3%), hand 11.2% (0.9%-25.7%), thigh 10.2% (3.2%-18.3%), head and neck 9.8% (0.6%-23.2%), calf 6.4% (1.4%-15.3%), chest/back 5.4% (0.9%-13.4%), hip 3.7% (1.2%-8.1%). Among them, the lower limb injury rate is the highest, which is the same as the previous research conclusion; Secondly, the injury rate of ankle/foot, knee and face ranks among the top three, which is in line with the characteristics of Taekwondo[9–12]. Taekwondo uses the leg technique as the main scoring means, and both fists and feet are used, so the lower limbs become the most vulnerable area. Due to the complex anatomical structure and weak stability of the knee joint, the center of gravity changes rapidly when performing technical and tactical actions such as rapid attack, turning and kicking, and the knee joint needs to bear a large shear stress, which increases the risk of injury[13].The ankle joint is prone to sprain or strain in rapid turning, jumping and other actions due to frequent body weight and impact[14]. In addition, head, neck and face injuries can be attributed to the rule of scoring on the head[15].

3.1.3. Type of injury

Ten studies reported data on injury types of taekwondo athletes, sorted by the average of injury rates for different injury types, without distinguishing between competition, training, gender, and age, among others. The results showed that the injury rates of different injury types from high to low were: contusion 45.6% (20%-72.3%), sprain 18.2% (5.1%-29.0%), strain 10.3% (3.0%-16.1%), fracture 9.2% (3.2%-21.1%), laceration 6.1% (0.6%-15%), concussion 5.5% (3.2%-7.6%), dislocation 1.7% (0.6%-5%). Contusion, sprain and strain are the main types of injuries in taekwondo at present, and this result is consistent with the conclusions of related studies[9,10], further illustrating the prevalence and importance of these injuries.

3.1.4. Severity of Injury

Injury severity A total of 4 studies have reported 1616 taekwondo athletes' injury severity grading during competition and training, and the grading types are mainly the following: (1) Category I [10]: mild injury (resulting in 13 days of time loss), moderate injury (resulting in 47 days of time loss), and severe injury (resulting in 7 days and more of time loss); (2) Category II[16]: Mild injury (injury in which the competition is suspended at the request of the competitor or the competition referee, medical intervention on the spot), Moderate injury (injury in which the competition is interrupted and the competition cannot be resumed), Severe injury (injury in which the competitor is not only stopped but also absent from training or competition for up to one week in the future), Critical injury (injury in which the competitor is not only stopped but also absent from training or competition for more than one week in the future). At the same time, aiming at the incidence of injuries in different tournaments, some studies have shown that the most injuries were suffered in the third round of taekwondo competitions, with 46 people (49.5%) injured, and 40 people (43.1%) and 7 people (7.5%) injured in the second and first rounds, respectively[16]. To sum up, Taekwondo injuries are mostly minor; The risk of injury in the third round of the game is greater than the first two rounds, and the risk of injury in the first round is the lowest.

3.1.5. Relationship between weight class and injury

Four grades were carried out according to the weight class of the Olympic Taekwondo Rules[17](flyweight: men <58 kg and women <49 kg; lightweight: men <68 kg and women <57 kg; welterweight: men <80 kg and women <67 kg; heavyweight: men> 80 kg and women> 67 kg). A total of 3 studies reported the incidence of injuries in different weight classes among

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3,378 taekwondo athletes. Ki Jun Park et al.[6] pointed out that the weight grade significantly affected the severity of injury. In male athletes: Class I injuries are most common in welterweight; Secondary injuries are most commonly seen in welterweights; Grade III injuries are most commonly seen in lightweights; However, among female athletes, injuries of any degree are most commonly seen in the welterweight division. Meanwhile, among men, welterweights had the highest incidence of injuries, followed by heavyweights, flyweights, and lightweights. Among women, welterweight athletes had the highest incidence, followed by lightweight, heavyweight, and flyweight athletes. The injury risk of female athletes peaks at the highest weight class (> 72 kg), while the injury risk of male athletes increases with weight class, peaking at <78 kg but decreasing again in higher weight classes[18]. Another study also showed[19]that the weight group with the highest number of injuries among male athletes was the <68 kg group (n =9, 21.95%). However, for female athletes, the weight class with the most injuries was the <49 kg class (n =6, 31.57%), and this conclusion was different from the above regarding the injury rates of female athletes in different weight classes. However, a study as early as 2007[19]found that there were no significant differences between athletes in the four weight classes: men and women.

3.1.6. Relationship between gender and injury

A total of eight studies reported the incidence of injuries across sexes in 10,376 taekwondo athletes. The results showed that in the rate/1000AE index, the injury incidence rate of men was 59.18 (38.46-79.9) /1000AE, and that of women was 25.35 (25.3-25.4) /1000AE; In the rate/1000 ME index, the incidence of injury was 7.12 (4.6-9.64) /1000 ME in men and 6.18 (5.26-7.1) /1000 ME in women; In the rate/100 athletes index, the incidence of injury was 15.5 (15.2-15.8) per 100 athletes for men and 10.2 (9.6-10.8) per 100 athletes for women. All the above three indicators suggest that the injury incidence of male taekwondo athletes may be greater than that of female taekwondo athletes. Studies have shown that male taekwondo athletes have a 1.5-fold[9], 1.57-fold[10], and 1.65-fold[11]higher risk of injury during competition than women, but the risk of injury during training is opposite for men and women. Boae Son et al.[20]argued that female athletes had a significantly higher risk of injury than male athletes during training, but no significant differences were observed in injury characteristics (site, type, mechanism, and time loss) between male and female athletes. However, there are also studies that suggest[6]that male athletes develop more grade I injuries and female athletes develop more grade II injuries, while male and female athletes have a similar risk of grade III injuries. In terms of injury mechanisms, men prefer to attack the lower limbs and head and neck, resulting in the lower limbs and head and neck being the most frequently injured areas; Women tend to attack the lower extremities and more often develop knee and foot injuries[12,21]. In terms of injury types, contusions were the most common in women, followed by sprains and strains; Sprains are most common in men, followed by joint dysfunction[21].

3.1.7. Relationship between age and injury

The age range involved in the study was mainly divided into youth (14-17 years) and adults (≥18 years), and a total of 3 studies reported the incidence of injuries at different ages in 3365 taekwondo athletes. A 2007 study showed[19]that there was no significant difference in the incidence of injuries among men at different ages, but that the incidence of injuries was significantly higher among young women than among adult women. If gender factors are not considered, Boae Son et al. [22]believe that the incidence of sports injuries in young taekwondo athletes is significantly greater than that in adult taekwondo athletes, whether it is training, competition or training + competition. It is worth mentioning that adult athletes lost> 7 days to injuries 2.82 times more than youth athletes, indicating that adult athletes are more likely to suffer serious injuries.

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3.1.8. Other relevant factors

Some studies have pointed out that over a 10-year period, 283 athletes experienced 1466 injuries, with an average of 4.6 injuries per person per year[6]; Amateur Taekwondo athletes are injured on average 2 times per year, and the vast majority of Taekwondo injuries occur during the training phase[23]. Of all the injuries, 56.7% were diagnosed as moderate or more severe and 60.3% required treatment by a health professional, of which 5.0% could result in permanent disability[23]. In terms of injury mechanisms, the most common injury mechanism is contact injury[22]. Athletes suffered contact injuries in 54 cases (73.0%) and non-contact injuries in 18 cases (24.3%); fractures and ligament tears caused by physical contact and non-contact occurred mostly in knee joints, ankles and fingers[9]. In terms of injury types, elite taekwondo athletes were more likely to suffer lower limb injuries, and ligament sprains were the most common injury types[22]. Meanwhile, the most common site of contusions/hematomas/bruises was the face[9]. In terms of daily training duration, athletes who trained for> 1 hour had a 4.20-fold higher risk than ≤1 hour per training session[24].

4. Discussion and Analysis

4.1. Contradictions in epidemiological characteristics

Different research results are controversial in the following three aspects, so the specific reasons are discussed further: First, the contradiction between competition and training injury risk: for example, Lystad et al.[23]found that 81.5% of injuries occurred in training (training> competition), while Gesslein et al.[25]showed that the competition injury risk was 6.33 times that of training (competition> training). The two studies reached opposite conclusions. Possible reasons include: (1) differences in statistical indicators, competition adopting rate/1000AE (which may overestimate competition risk due to short but high intensity of competition exposure), and training due to adopting rate/100athletes (which reflects long-term cumulative risk due to long training cycle); (2) The difference between retrospective studies and prospective studies. Most of the training injury data comes from retrospective studies such as questionnaires, while the competition injury data comes from prospective studies such as on-site medical records; (3) Difference between competition time and training time. Taekwondo competition is divided into 3 rounds, each round is 2min, interval is 30s ~1min, and the total competition time is about 7~8min. While the training time is several hours/day, 5-6 days/week. Complex factors such as intensity and time cause the injury rate of training and competition to fail to form a horizontal contrast; (4) Population heterogeneity. The research objects in the included literature include different countries and regions, different event levels, amateur taekwondo, professional taekwondo, etc., and the injury risk is quite different. Second, the controversy of gender differences: High risk of male competition: The injury rate of male competition (59.18/1000AE) is significantly higher than that of female (25.35/1000AE), which may be due to the high frequency of male aggressive techniques (such as high spin kicks)[10]. Higher training risk for women: Son et al. [26]found that the higher training injury rate for women may be related to the influence of female hormone cycle on ligament relaxation (e.g., estrogen fluctuation during menstrual cycle increases the risk of knee ACL injury) and the difference in training load tolerance. Third, the disagreement between weight class and injury: A 2007 study[19]found that there were no significant differences between athletes in four weight classes: men and women. Current research shows that male welterweight athletes have the highest incidence of injury and women have the highest injury severity in welterweight or flyweight, breaking the idea that injury risk increases with increasing weight class.

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4.2. High Risk Attribution for the Third Round

The first is the cumulative effect of fatigue: including increased heart rate, lactic acid accumulation, and prolonged reaction time. (1) Increased heart rate: At the third round, the highest heart rate of athletes was very significantly higher than that of the previous two rounds ($P < 0.01$), and at the same time, the highest heart rate increased very significantly in the 1st, 2nd, and 3rd games ($P < 0.01$)[26]. (2) Lactic acid accumulation: The blood lactic acid values of athletes can reach (9.36 ± 1.69) mmol/L (male) and (8.27 ± 3.29) mmol (female) 3min after the end of the third game, suggesting that the glycolysis energy supply system is involved in causing blood lactic acid accumulation. [26]When blood lactic acid reaches the peak, the degree of fatigue rises sharply. Under the fatigue state, the kinematic parameters of ankle joint in sudden start, sudden stop and torsion are significantly different, and fatigue leads to an increase in ankle joint mobility, resulting in a decrease in the stability of body center of gravity and a poor fluency of cross kick movement. The above situation affects the use effect of cross-kick action, and at the same time increases the risk of ankle sports injury[27]. (3) Prolonged reaction time[27]: In one study, the kick impact was significantly reduced in the fatigue state compared before and after the progressive taekwondo test, and the reaction time was significantly higher than before the test.

The second is the radical upgrade of tactics: in the decisive game, the frequency of high-risk techniques (such as high horizontal kick and round kick) increases, but the completion of actions decreases, resulting in unstable landing and damage. At the same time, the frequency of challenges on offense and counter-attack increases greatly[28]. In terms of tactics for each round, immediate and anticipated actions were more frequent in the third round than in the previous rounds ($p <= 0.05$)[29]. Electronic protective gear scoring rules (which require accurate touch sensors) force athletes to adopt "extreme distance attack" in the third round, which may increase the probability of physical imbalance.

4.3. Limitations of the study

This study, although detailed epidemiological elaboration of Taekwondo, still has deficiencies. First, data quality deficiencies: (1) Retrospective bias: 50% of the studies used questionnaire surveys[30,31], which may have memory bias, underreporting of minor injuries, exaggerating or weakening certain injuries, etc. (2) Underrepresentation of the sample: only 24 studies met the inclusion criteria, and the data from Africa and South America were missing in the included literature, and the proportion of amateur athletes was only 12%, which could not reflect the whole picture of global taekwondo injuries. Secondly, the mechanism research is shallow: (1) The depth of action analysis is insufficient: the dynamics and kinematics analysis of technical actions with high injury risk (such as high cross kick and rotation kick) is less, and it is difficult to clarify the specific mechanical mechanism of injury. At the same time, there is a lack of dynamic confrontation data in real games (such as the opponent's blocking reaction force); (2) Weak research on the effect of protective equipment: There is limited research evidence on how protective gear (such as shin protection and head protection) can change the impact force distribution and reduce the risk of injury. (3) Lack of quantification of psychological factors: psychological indicators such as aggressive intention and risk preference are not included in the damage prediction model. Third, the longitudinal tracking is missing: (1) Lack of long-term tracking: lack of tracking the follow-up rehabilitation effect, recurrence risk and conversion to chronic injury (such as arthritis and chronic pain) of acute injury (such as ligament tears and fractures); (2) The disability rate and quality of life after retirement of chronic injuries (such as joint degenerative lesions, chronic ankle instability, etc.) and repetitive injuries are unknown. (3) In the future, a standardized tracking system can be established, a special injury database for Taekwondo can be formulated, and the injury definition, recording frequency and evaluation indicators (such as imaging and biomechanical parameters) can be unified.

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5. Conclusions

Through a systematic literature review, the following conclusions are drawn: (1) The epidemiological characteristics of Taekwondo injury are influenced by statistical methods, rule iteration and population heterogeneity, so it is necessary to establish a global unified surveillance standard. (2) There are few dynamics and kinematics analyses of technical actions with high injury risk (such as high horizontal kick and rotary kick). In the future, it is necessary to study and explore the specific injury mechanics mechanism and dynamic confrontation data in the game. At the same time, the future research directions are proposed: (1) Standardization action: Promote the cooperation between World Taekwondo Federation (WT) and International Federation of Sports Medicine (FIMS) to develop injury definition and data collection guidelines. (2) Technological innovation: Develop embedded sensor protective gear to monitor the impact strength and joint load in real time, and realize early warning of injury risk. (3) Interdisciplinary research: integrate neuroscience (post-concussion functional assessment) and material science (optimization of protective gear energy-absorbing materials) to build a full-chain intervention system of "prevention, monitoring and rehabilitation".

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