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RESEARCH ARTICLE

Comparative Analysis of in-Competition Sports Injuries in Different Taekwondo Tournaments: Seniors, Juniors and Para-Taekwondo

Farklı Taekwondo Turnuvalarında Müsabaka İçi Spor Yaralanmalarının Karşılaştırmalı Analizi: Büyükler, Gençler ve Para-Taekwondo

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ABSTRACT

Objective: Taekwondo is a combat sport that combines physical skill and strategic thinking that carries a risk of injury due to its high-paced, contact-based nature. This study analyzed injury incidence and characteristics in senior (STC), junior (JTC), and para-taekwondo (PTC) championships in Türkiye. The aim was to identify injury patterns and guide prevention strategies.

Materials and Methods: Data were collected using the International Olympic Committee's 'Daily Report on Injuries and Illness' form by sports medicine physicians present at the tournaments. Variables included injury type, affected body part, mechanism, and whether athletes could continue competing. Data were analyzed retrospectively.

Results: In STC, 232 injuries occurred among 222 athletes, with a mean age of 19.4 ± 2.4 years and sports experience of 10.0 ± 3.1 years. In JTC, 234 injuries were recorded in 232 athletes, with a mean age of 16.0 ± 1.1 years and sports experience of 6.0 ± 1.5 years. In PTC, 31 injuries were reported among 30 athletes, with a mean age of 22.0 ± 5.9 years and sports experience of 6.4 ± 2.9 years. Injury incidence was highest in PTC (40.8/100 clinical; 469.7/1000 competitions), followed by STC (18.9/100 clinical; 191.4/1000 competitions) and JTC (9.4/100 clinical; 100.9/1000 competitions). Male athletes were injured more frequently in all tournaments, but female injuries were proportionally higher in JTC. Contusions were the most common injury type, and lower extremity injuries were most frequent across all tournaments. However, head and trunk injuries were more common in JTC. The primary injury mechanism was contact with another athlete, with no significant differences between groups. The ability to continue competing after injury did not differ significantly across tournaments.

Conclusion: Based on the results of this study, we strongly recommend improving taekwondo competition rules, developing on-site medical systems, and implementing strategic plans and safety measures for injury prevention, especially in para-taekwondo competitions. These steps may help athletes, coaches and federations create safer environments, and support long-term athlete health and performance.

Keywords: Taekwondo, taekwondo injuries, combat sports, para-athletes, injury prevention

ÖZ

Amaç: Taekwondo, fiziksel beceri ve stratejik düşünceyi birleştiren ve yüksek tempolu, temasa dayalı doğası nedeniyle yaralanma riski taşıyan bir dövüş sporudur. Bu çalışmada, Türkiye'deki büyükler (STC), gençler (JTC) ve para-taekwondo (PTC) şampiyonalarında saptanan yaralanma insidansı ve özellikleri analiz edildi. Amaç, yaralanma modellerini belirlemek ve önleme stratejilerine rehberlik etmekti.

Yöntem: Veriler, Uluslararası Olimpiyat Komitesi'nin 'Günlük Yaralanma ve Hastalık Raporu' formu kullanılarak turnuvalarda hazır bulunan spor hekimleri tarafından toplanmıştı. Değişkenler arasında yaralanma türü, etkilenen vücut bölgesi, yaralanma mekanizması ve sporcuların yarışmaya devam edip edemediği yer aldı. Veriler retrospektif olarak analiz edildi.

Bulgular: STC'de yaş ortalaması 19.4 ± 2.3 yıl ve spor deneyimi 10.0 ± 3.1 yıl olan 222 sporcuda 232 yaralanma, JTC'de yaş ortalaması 16.0 ± 1.1 yıl ve spor deneyimi 6.0 ± 1.5 yıl olan 232 sporcuda 234 yaralanma, PTC'de yaş ortalaması 22.0 ± 5.9 yıl ve spor deneyimi 6.5 ± 2.9 yıl olan 30 sporcuda 31 yaralanma kaydedildi. Yaralanma insidansı en yüksek PTC'de (40.8/100 klinik; 469.7/1000 müsabaka) gözlenirken, bunu STC (18.9/100 klinik; 191.4/1000 müsabaka) ve JTC (9.4/100 klinik; 100.9/1000 müsabaka) izledi. Erkek sporcular tüm turnuvalarda daha sık yaralandı. Kontüzyonlar en sık görülen yaralanma tipiydi ve alt ekstremite yaralanmaları tüm turnuvalarda en sık görülen yaralanmalardı. Bununla birlikte, kafa ve gövde yaralanmaları JTC'de diğer turnuvalara kıyasla daha fazla gerçekleşti. En sık gözlenen yaralanma mekanizm-

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ası başka bir sporcuyla temastı ve gruplar arasında anlamlı bir fark yoktu. Yaralanma sonrasında yarışmaya devam edebilme açısından turnuvalar arasında anlamlı bir fark yoktu.

Sonuç: Bu çalışmanın sonuçlarına dayanarak, taekwondo müsabaka kurallarının iyileştirilmesini, saha içi tıbbi sistemlerin geliştirilmesini ve özellikle para-taekwondo müsabakalarında yaralanmaların önlenmesi için stratejik planların ve güvenlik önlemlerinin uygulanmasını şiddetle öneriyoruz. Bu adımlar, sporcuların, antrenörlerin ve federasyonların daha güvenli ortamlar yaratmasına ve sporcuların uzun vadeli sağlığının ve performansının desteklemesine yardımcı olabilir.

Anahtar Sözcükler: Taekwondo, taekwondo yaralanmaları, dövüş sporları, para-atletler, yaralanmaların önlenmesi

INTRODUCTION

Taekwondo is a combat sport and Olympic discipline that originated in Korea and has gained worldwide popularity [1]. Requiring both physical skill and strategic thinking, the sport is characterized by its high tempo and full-contact nature during competitive matches. However, these dynamic and exciting characteristics are also associated with an inherent risk of injury for athletes. Epidemiologic studies on sports injuries are essential to understand the incidence, mechanisms and associated risk factors of these injuries, thereby informing about preventive measures and improving athlete safety [2].

Taekwondo demonstrates a high injury incidence rate due to its martial art-based, full-contact nature. Reports indicate that taekwondo had the highest injury rate at the London Olympics in 2012 [3], the second highest in Beijing in 2008 [4] and the fourth highest in Rio in 2016 [5]. In recent years, changes in taekwondo rules and technological advancements have been introduced as measures to reduce injury rates. Since the 2016 Rio Olympic Games, World Taekwondo (WT) has revised its competition rules and implemented a more precise protective equipment and scoring system [6]. These changes were also applied at the WT supported Muju 2017 World Taekwondo Championships (WTC) [7] and Manchester 2019 WTC [8]. At the Muju 2017 WTC, 131 out of 971 athletes experienced an injury (13.5/100 clinical incidence) [7]. The in-competition injury incidence rate at Manchester 2019 was lower than in tournaments held prior to the introduction of the new scoring system: 60 out of 936 athletes (6.4/100 clinical incidence) sustained injuries. By comparison, injury rates in earlier Olympic Games were higher: 34 out of 126 athletes (27/100 clinical incidence) in Beijing 2008, 50 out of 128 athletes (39/100 clinical incidence) in London 2012, and 30 out of 127 athletes (24/100 clinical incidence) in Rio 2016 suffered injuries.

Since the 2017 WTC, electronic head protectors and chest protectors have been introduced to fully automate the scoring system. This innovation allows taekwondo athletes to score points with lighter kicks to the head, reducing the force required compared with previous practices [6,9]. Consequently, injury rates in recent international taekwondo competitions may have been decreased, as athletes now prioritize strategies involving light contact with their opponents' head and chest protectors rather than relying on powerful kicks to score points. Despite these advances, updated epidemiologic data are needed to reflect current trends and inform evidence-based interventions.

This study aims to provide a comprehensive analysis of the incidence, distribution, and associated risk factors of injuries occurring during taekwondo competitions. There is a gap in the literature on the epidemiology of injuries during para-taekwondo competitions. This study also aims to fill this gap and highlight the differences between para-taekwondo and taekwondo athletes. By examining differences in injury patterns among senior, junior and para-taekwondo athletes, identifying high-risk groups, and explaining injury mechanisms, the study aims to contribute to the development of targeted injury prevention strategies. Ultimately, it seeks to enhance safety and sustainability in taekwondo.

MATERIAL AND METHODS

Athletes who sustained injuries during the Türkiye Senior Taekwondo Championship (STC), Türkiye Junior Taekwondo Championship (JTC) and Türkiye para-Taekwondo Championship (PTC) held in Ankara in January 2025, were evaluated by two sports medicine

physicians assigned to the tournaments. Injuries were recorded using the International Olympic Committee's (IOC) Injuries and Illnesses Daily Report form. An injury was defined as any situation requiring the assistance of on-site medical personnel. The following data were documented for each injured athlete: age, sport experience (sport age), gender, type of injury, mechanism of injury, body part affected, and whether the athlete was able to continue competing.

In this study, injury incidence was evaluated using the concept of clinical incidence, defined as the number of injured athletes per 100 registered participants [4,10], and injuries per 1000 matches [10,11]. This approach provides a practical overview of the injury burden at the individual level, and is widely utilised in the epidemiology of sports injuries. In addition, in accordance with international consensus statements [10], injuries were classified as time-loss injuries or medical attention injuries. Time-loss injuries refer to injuries that prevent the athlete from participating in training or competition for at least one day following the injury, while medical attention injuries include all injuries that require evaluation or treatment by medical personnel, regardless of time loss. In this study, medical attention injuries occurring on the field were evaluated.

Ethics committee approval was obtained from the local ethics committee to conduct the study (Decision No: 2025/34, Decision Date: 06.02.2025).

Statistical Analysis

A frequency analysis was performed to examine the characteristics of the injured athletes. A chi-squared test was used to analyze differences in injury characteristics across the three tournaments (STC, JTC and PTC). The significance level was set at $p<0.05$. All statistical analyses were conducted using the Jamovi (version 2.3) software.

RESULTS

Overall injury incidence

The mean age of injured athletes competing in STC, JTC and PTC was 19.4 ± 2.4 years, 16.0 ± 1.1 years, and 22.0 ± 5.9 years, respectively. Their mean sports ages are also given in Table 1. The distribution of injuries observed in all three national competitions is given in Table 2 according to gender. There were 0.19 injuries per competition in STC, 0.10 injuries per competition in JTC and 0.46 injuries per competition in PTC.

A crossover analysis was performed to analyze the differences in gender according to the competition. The injury rate of female athletes was 36.2% in STC, 45.7% in JTC and 29.0% in PTC (Table 1). Female athletes were injured more in JTC compared to other tournaments. Results revealed significant differences in gender among seniors, juniors and para-taekwondo ($\chi^2=6.12$, $p=0.047$).

Injury type according to the competition

A crossover analysis was performed to analyze the differences in injury type according to the competition (Table 3). Results displayed no significant differences in injury type among seniors, juniors and para-taekwondo athletes ($\chi^2=26.2$, $p=0.096$). For seniors, the most frequent injury types were contusions (74.1%), followed by sprains (7.8%) and dislocations/subluxations (7.3%). For junior athletes, the most frequent injury types were contusions (83.3%), followed by sprains (6.4%) and strains/muscle ruptures/tears (3.8%). For para-taekwondo athletes, the most frequent injury types were contusions (83.9%), followed by sprains (12.9%).

Table 1. General characteristics of study participants

Characteristics		STC	JTC	PTC	Total
Gender*	Male	148 (63.8%)	127 (54.3%)	22 (71%)	297 (59.8%)
	Female	84 (36.2%)	107 (45.7%)	9 (29%)	200 (40.2%)
Age (yr)**		19.4±2.4	16.0±1.1	22.0±5.9	17.8±2.9
Sports age (yr)**		10.0±3.1	6.0±1.5	6.4±2.9	7.8±3.0

*STC: Türkiye Senior Taekwondo Championship; JTC: Türkiye Junior Taekwondo Championship; PTC: Türkiye para-Taekwondo Championship; *: data given as n (%); **: data given as mean±SD.*

Table 2. In-competition injuries of athletes in senior, junior, and para-taekwondo tournaments

Group	Parameter	Male	Female	Total
STC	Number of athletes	631	597	1228
	Number of competitions	623	589	1212
	Number of Injuries	148	84	232
	Injuries/1000 competitions*	237.6	142.6	191.4
	Clinical incidence/100 athletes**	23.5	14.1	18.9
JTC	Number of athletes	1195	1307	2502
	Number of competitions	1065	1253	2318
	Number of injuries	127	107	234
	Injuries/1000 competitions	119.2	85.4	100.9
	Clinical incidence/100 athletes	10.6	8.2	9.4
PTC	Number of athletes	49	27	76
	Number of competitions	44	22	66
	Number of injuries	22	9	31
	Injuries/1000 competitions	500.0	409.1	469.7
	Clinical incidence/100 athletes	44.9	33.3	40.8

*STC: Türkiye Senior Taekwondo Championship; JTC: Türkiye Junior Taekwondo Championship; PTC: Türkiye para-Taekwondo Championship. *: total no of injuries/total no of competitions x 1000. **: number of injured athletes/the total number of athletes x 100.*

Injury by body part according to the competition

Crossover analysis was performed to analyze the differences in injuries by body part according to the competition (Table 4). Results revealed significant differences in injuries by body part among seniors, juniors and para-taekwondo athletes ($\chi 2=96.7$, $p<0.001$). For seniors, the most frequently affected body parts were the lower extremity (55.3%), followed by the upper extremity (24.1%). More specifically, the most commonly affected body parts in seniors were the foot/toe (15.1%), followed by the face (14.7%), fingers (11.6%) and knee (10.8%).

For juniors, the most frequently affected body parts were the lower extremity (49.1%), followed by the head and trunk (36.2%). More specifically, the most commonly affected body parts in juniors were the face (32.1%), followed by the thigh (11.5%), finger (11.1%) and foot/toe (10.3%). For para-taekwondo athletes, the most frequently affected body parts were the lower extremity (61.3%), followed by the upper extremity (32.3%). More specifically, the most commonly affected body parts in para-taekwondo athletes were the groin (16.1%), followed by foot/toe, knee and thigh (12.9% each) (Table 4).

Table 3. Types of injuries that occurred in senior, junior and para-taekwondo tournaments

Variables	STC	JTC	PTC	Total	χ^2	df	p
Contusion	172	195	26	393	26.2	18	0.096
Sprain	18	15	4	37			
Tendinopathy	1	0	0	1			
Strain/muscle rupture/tear	10	9	1	20			
Fracture	5	2	0	7			
Concussion	2	7	0	9			
Dislocation/subluxation	17	2	0	19			
Ligamentous rupture	2	2	0	4			
Muscle cramps or spasm	1	0	0	1			
Other	4	2	0	6			
Total	232	234	31	497			

STC: Türkiye Senior Taekwondo Championship; JTC: Türkiye Junior Taekwondo Championship; PTC: Türkiye para-Taekwondo Championship; χ^2: chi-squared test; df: degrees of freedom; significance set to p<0.05; data as number of injuries.

Mechanisms of injury type according to the competition

Results displayed no significant differences in the mechanisms of injury among seniors, juniors, and para-taekwondo athletes ($\chi2=4.15$, $p=0.656$) (Table 5). The most frequent injury mechanisms were contact with another athlete (87.7% for seniors, 88.8% for juniors and 93.5% for para-taekwondo athletes), and non-contact trauma (11.0% for seniors, 11.2% for juniors; and 6.5% for para-taekwondo athletes).

Severity of injury according to the competition

The results revealed no significant differences in the result after injury among seniors, juniors, and para-taekwondo athletes ($\chi2= 4.13$, $p=0.389$). For seniors, the most frequent result after injury was completed game (n=193, 83.2%), withdrawal (n=30, 12.9%) and referred to hospital (n=9, 3.9%). For juniors, the most frequent result was the completed (n=197, 84.2%), withdraw (n=27, 11.5%) and referring to hospital (n=10, 4.3%). For para-taekwondo athletes, the most frequent result was completion (n=30, 96.8%) and withdrawal (n=1, 3.2%) (Table 6).

DISCUSSION

This study investigated in-competition injury differences in senior, junior, and para-taekwondo championships in Türkiye. The results of the study disclosed that there were statistically significant differences between the genders of the injured athletes and the injured body parts when the three tournament types were compared. Para-taekwondo championships (PTC) had the highest incidence of in-competition injuries. In all three tournaments, male athletes were injured more than female athletes. The most common injury type in all three groups was contusion. Lower extremity injuries were most common in all three groups. Contact with another athlete was the most common injury mechanism in all three groups. While no athlete was referred to hospital in para-taekwondo competitions, there was no difference between the groups in terms of results after injury. The results revealed that different injuries occur during different taekwondo tournaments, and that different strategies should be planned for the prevention of these injuries accordingly.

Table 4. Body parts of injuries involved in senior, junior and para-taekwondo tournaments

Variables	STC	JTC	PTC	Total	χ^2	df	p
Lower leg	16	14	0	30			
Forearm	5	3	0	8			
Foot/toe	35	24	4	63			
Knee	25	22	4	51			
Face	34	75	0	109			
Ankle	4	16	1	21			
Achilles tendon	1	0	0	19			
Hand	10	0	1	11			
Thigh	18	27	4	49			
Groin	25	11	5	6			
Abdomen	1	0	0	1			
Thumb	4	0	0	4			
Wrist	1	1	0	2			
Head	7	5	3	15	96.7	50	<0.001
Finger	27	26	4	57			
Upper arm	3	2	2	7			
Shoulder	1	0	0	1			
Gastrointestinal	1	0	0	1			
Hip	3	0	1	4			
Elbow	2	2	2	6			
Sternum/ribs	1	1	0	2			
Cardiovascular	3	2	0	5			
Shoulder/clavicula	0	2	0	2			
Neck/cervical spine	1	1	0	2			
Lumbar spine/lower back	2	0	0	2			
Thoracic spine/upper back	2	0	0	2			
Total	232	234	31	497			

STC: Türkiye Senior Taekwondo Championship; JTC: Türkiye Junior Taekwondo Championship; PTC: Türkiye para-Taekwondo Championship; χ^2: chi-squared test; df: degrees of freedom; significance level set to p<0.05; data as number of injuries.

Table 5. Mechanisms of injuries that occurred in taekwondo tournaments

Variables	STC	JTC	PTC	Total	χ^2	df	p
Contact with another athlete	200	206	29	435			
Non-contact trauma	25	26	2	53			
Overuse	1	0	0	1	4.15	6	0.656
Recurrence of previous injury	2	0	0	2			
Total	232	234	31	497			

STC: Türkiye Senior Taekwondo Championship; JTC: Türkiye Junior Taekwondo Championship; PTC: Türkiye para-Taekwondo Championship; χ^2: chi-squared test; df: degrees of freedom; significance level set to p<0.05; data as number of injuries.

In STC, 18.9/100 clinical incidence and 191.4 injuries/1000 competitions occurred. Looking at previous studies, it is observed that 27/100 clinical incidence was reported in Beijing 2008 Summer Olympics [4], and 39/100 clinical incidence was reported in London 2012 [3]. After the change of rules by WT in 2016, 24/100 clinical incidence in Rio 2016 [5], 13.5/100 clinical incidence in Muju 2017 WTC [7], 6.4/100 clinical incidence in Manchester 2019 WTC occurred. Thus, the incidence of injuries decreased in major organisations following the

change of rules. However, in our study, it is observed that the incidence of injury is still high in senior competitions. In our study, 9.4/100 clinical incidence and 100.9 injuries/1000 competitions occurred in JTC. This result is similar to the clinical incidence of 7.5/100 in the 2018 World Junior Championships. In our study, the lowest incidence of injury among the three tournaments occurred in JTC. About 40.8/100 clinical incidence and 469.7 injuries/ 1000 competitions occurred in PTC.

Table 6. Outcomes after injuries in taekwondo tournaments

Variables	STC	JTC	PTC	Total	χ^2	df	p
Completed	193	197	30	420	4.13	4	0.389
Withdrawn	30	27	1	58			
Referred to hospital	9	10	0	19			
Total	232	234	31	497			

STC: Türkiye Senior Taekwondo Championship; JTC: Türkiye Junior Taekwondo Championship; PTC: Türkiye para-Taekwondo Championship; x^2: chi-squared test; df: degrees of freedom; level of significance set to p<0.05; data as number of injuries.

There are few studies documenting in-competition injuries in para-taekwondo tournaments. In these studies, the clinical incidence was 8.0/100 in the 5th World Para-Taekwondo Championship [12] and 9.5/100 in the 2014 European Para-Taekwondo Championship [11]. In our study, the high incidence of injury in para-taekwondo kyurugi K44 competitions is quite remarkable. This situation can be explained by differences in rules and the use of protective equipment. It was determined that para-taekwondo athletes frequently use their amputated limbs and receive many blows during competition. The development of protective equipment for amputated limbs may play an important role in preventing injuries. The prohibition of head strikes in para-taekwondo is an important factor in the low incidence of head injuries. However, this may lead to an increase in the frequency of repeated strikes to the lower extremities, and increase the incidence of linked injuries. This result suggests that para-taekwondo competition rules and safety equipment should be revised and that more studies revealing the injury epidemiology of para-taekwondo competitions are needed.

In all three tournaments, male athletes were injured more than than the females. This result is consistent with the findings of previous studies: 2017 [7] and 2019 [8] seniors' World Taekwondo Championships, 2014 World Para-Taekwondo Championships [12] and 2018 World Junior Taekwondo Championships [13], which revealed that male athletes were more injured. On the other hand, in two studies conducted in 2001 and 2011, it was reported that female athletes were injured more than the males [14,15]. In 2016, rule changes in taekwondo may have had an effect on the increase in the frequency of injuries in male athletes. The discrepancy between the intended effects of rule changes and the actual behavior of male athletes in competition may have contributed to the high incidence of injuries. This discrepancy has been exacerbated by factors such as the slow adaptation of power-based techniques, higher competition exposure, and inadequate protective equipment, especially in high-contact weight classes.

The most common type of injury was contusion in all three tournaments. Similarly, recent studies have reported that contusion is the most common type of injury during taekwondo tournaments [7,8,12,13]. In 2017 and 2019 seniors' World Taekwondo Championships and 2018 World Junior Taekwondo Championships, contusion was reported as the most common injury [13]. Concussions occurred in two athletes in the senior tournament, in seven athletes in the junior tournament, and no concussions occurred in the para-taekwondo tournament. In previous taekwondo competitions, many serious injuries such as concussions were observed at high incidence [1,16]. However, there seems to be a change in the injury profile after the 2016 rule changes. This seems to be a result of the competition

strategy of athletes to score points by lightly touching the head sensor with their feet instead of kicking, which can transfer strong impact. Improvement of the applied rules can be evaluated positively in terms of reducing concussions.

The most frequently injured body parts were lower extremities and foot/toe in STC, lower extremities and face in JTC, and lower extremities and groin in PTC. In previous studies, the most frequently injured body region in senior competitions was the lower extremities, similar to our study [7,8,11]. There are few studies about in-competition injuries in para-taekwondo tournaments, and the small population of injured athletes is noteworthy. Lower extremity injuries are also prominent in para-taekwondo tournaments [11,12]. In the Junior World Championships held in 2018, lower extremity injuries were the most common ones, but specifically, similar to our study, face injuries were in the first place [13]. Face injuries including the nose, eye and ear were the most common ones in JTC. Among these, almost all of the face injuries occurred as nosebleeds. We think that the higher number of face injuries in JTC is related to the knowledge, sports age and skill level of the athletes [17,18].

The most common injury mechanism observed during the three national tournaments was contact with another athlete, followed by non-contact injuries. Similar to previous studies, contact with another athlete was the most common injury mechanism in competition. In taekwondo, a combat sport, most injuries still occur during attack and defence movements. Therefore, to prevent contact-type injuries, the amount of impact absorbed by protective equipment should be increased, and more shock-absorbing protective equipment should be developed [19]. Appropriate blocking techniques and defence skills should be included more in taekwondo training as preventive strategies.

In our study, withdrawal from the competition and hospital referral of the athlete were similar in STC and JTC after injuries that occurred during the competitions. However, only one athlete withdrew from the competition in PTC and no athlete was referred to hospital. In STC, five athletes were referred to hospital due to fracture, three athletes due to dislocation/subluxation and one athlete due to concussion. In JTC, seven athletes were referred to hospital due to concussion and one athlete due to fracture. Although the number of concussion in JTC seems to be high, it is consistent with previous studies [13]. In STC, fewer concussions were observed comparing to previous studies [7,8]. This may be due to the fact that senior athletes are more experienced than the juniors. Although the incidence of injury was higher in PTC comparing to STC and JTC, serious injuries were considerably less compared with other tournaments. Assessing previous studies, serious injuries such as concussion and fractures occurred in two para-taekwondo tournaments in 2014 [11,12], but only one athlete could not complete the competition due to a blow to the groin in the PTC.

Limitations

In our study, we analysed the incidence, type, site, mechanism and severity of injuries in tournaments. Physicians knowledgeable and experienced in sports-related injuries have diagnosed and recorded injuries in the field. While the present study provides valuable insights into injury patterns across different taekwondo athlete categories, this study has several limitations that should be acknowledged. As a retrospective analysis, the research relied on existing injury records, which may have been influenced by inconsistencies in documentation and reporting practices. Potential reporting bias could arise from under-reporting of minor injuries or subjective interpretation of injury severity by medical staff. In addition, variability among observers in identifying and classifying injuries, as well as differences in coaches' or athletes' willingness to report injuries may have affected the accuracy and completeness of the dataset. These factors could influence the internal validity of the findings. To improve data reliability in future studies, prospective designs with standardized injury surveillance protocols and inter-observer calibration are recommended.

The data were collected from national-level competitions held in Türkiye, and as such, may not fully reflect

the injury profiles of athletes competing in different regions or under varying organizational, environmental, or cultural conditions. Factors such as training methods, coaching philosophies, rule enforcement, access to medical support, and even athlete anthropometrics may vary significantly across countries, potentially influencing both the occurrence and reporting of injuries. Therefore, caution is warranted in extrapolating these results to global taekwondo populations, and future research involving multi-national or cross-cultural samples is recommended to enhance external validity.

Lack of information about previous injuries, unknown pre-competition injury status, and lack of questioning of the time away from sport after injury also can be considered as limitations of the study. Athletes with pre-existing injuries are likely to participate in competitions before full recovery, as they need to continue high-intensity training and training sessions before the competition. In addition, pre-existing injuries may influence the occurrence of other injuries during competition. Another limitation of this study is the inability to distinguish time-loss injuries Injuries. Since it is unknown how long the athlete was sidelined from sports after the injury, it was not possible to classify the injuries according to time-loss criteria. This situation limits the interpretation of the severity of the injury and its functional impact on athlete performance and participation.

CONCLUSION

This is the first study to investigate and compare the epidemiology of injuries in different taekwondo tournaments such as senior, junior and para-taekwondo. Results of the study disclosed that head and face injuries were more frequently seen in junior tournaments compared with the senior and para-taekwondo tournaments. The overall incidence of injury was highest in the para-taekwondo tournament. However, the incidence of injuries caused by contact during the opponent's attack is still very high. Also, male taekwondo players are more prone to injury comparing to female players. Based on the results of this study, we strongly recommend improving taekwondo competition rules, and developing strategic plans and safety measures for injury prevention. Establishing standardized, on-site medical support systems and developing category-specific injury prevention protocols, including neuromuscular training, protective equipment optimization, and targeted education programs, are also advised.

As a take-home message, these results underscore the need for collaborative efforts among athletes, coaches, medical professionals and federations to create safer competition environments, and inform future policy-making with evidence-based strategies tailored to the specific risks associated with each tournament category.

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Ethics Committee Approval
The study was approved by University of Health Sciences Gulhane Training and Research Hospital, non-interventional scientific research ethics committee.

Conflict of Interest
The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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