

Wrestling injuries during the 2016 Rio and 2020 Tokyo Olympic Games

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ABSTRACT

Objectives To evaluate and compare the injuries of Olympic wrestlers during the 2016 Rio and 2020 Tokyo Olympic Games held in August 2021 due to the COVID-19 pandemic.

Methods In this descriptive epidemiological study, injury report forms were used to collect and analyse injury data during the competitions.

Results During 410 matches in the Rio Olympic Games, 21 injuries were recorded among 346 wrestlers (112=women), a rate of 5.1 injuries/100 bouts and 6.1 injuries/100 athletes. During 322 matches in the Tokyo Olympic Games, 28 injuries were recorded among 287 wrestlers (96=women), with 8.7 injuries/100 bouts and 9.8 injuries/100 athletes. However, these apparent differences in injury rates between Tokyo and Rio were not statistically significant (injuries/bout: $p=0.057$, 95% CI: 0.31 to 1.02; injuries/athlete: $p=0.087$, 95% CI: 0.33 to 1.08). Mild injuries comprised the greatest proportion of injuries in both Olympic Games. Severe injuries accounted for 0%, 16.7% and 36.4% of injuries in Greco-Roman, Freestyle and Women's wrestling, respectively.

Conclusion Most wrestling injuries in the 2016 Rio and 2020 Tokyo Olympic Games were mild skin injuries in the head and face regions due to direct body contact during standing positions in the 1/8-final round of wrestling competitions. No critical injury was observed during the recent Olympic Games. Attention should be drawn to preventing upper limb joint dislocations as common severe injuries in both Olympic Games. While not statistically significant, the Tokyo Games, after the COVID-19 pandemic, witnessed a higher injury occurrence than the Rio Games.

INTRODUCTION

Wrestling is known to be one of the most ancient forms of combat, as cave drawings from 15 000 years ago illustrate wrestling. Wrestling was one of the first competitions included in the ancient Olympic Games in 708 BC.¹ Men's wrestling has been part of modern Olympic competitions since the inaugural Games in 1896 in Athens. After the 2000 Olympic Games in Sydney, women's wrestling was approved as an Olympic sport, and at the 2004 Olympic Games in Athens, female wrestlers competed for the first time.

Olympic wrestling is held in three different styles: Greco-Roman wrestling (GR), Freestyle wrestling (FS) and Women's wrestling (WW).² In GR, holding the opponent below the waist or using legs in the execution of any action is strictly forbidden. In FS, using leg techniques is allowed. WW uses a

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Olympic-style wrestling, as a contact sport, is associated with a variety of soft tissue and musculoskeletal injuries; therefore, injury prevention is crucial for the health of athletes.

WHAT THIS STUDY ADDS

- ⇒ The rate of wrestling injuries was recorded at 6.1 per 100 athletes at the 2016 Rio Olympics and 9.8 per 100 athletes at the 2020 Tokyo Olympics.
- ⇒ Athlete sex did not emerge as a risk factor; however, wrestlers in lower weight categories had a higher likelihood of injury.
- ⇒ No critical injuries occurred during the recent Olympic Games' wrestling competitions. Although infrequent, shoulder and elbow joint dislocations were the most concerning injuries in wrestling.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ This study broadens our knowledge of injury patterns and epidemiology in Olympic wrestling, which can help to develop more effective injury prevention strategies.

different weight category but follows the same rules of FS, forbidding, however, the Double Nelsons has the same ruleset as FS wrestling; there is no difference other than the sex of the competitors and the weight categories.³ Each wrestling style hosts wrestlers in six different weight categories during the Olympic Games. The number and duration of periods in wrestling bouts may differ based on the level of competition. The official wrestling competitions, governed by United World Wrestling (UWW), consist of two periods of 3 min each with a 30 sec rest in between.

As a contact sport, injury prevention is of the utmost importance in Olympic wrestling. To achieve this, regular monitoring and analysis of the occurrence, characteristics, risk factors and causes of injuries is necessary. Hence, the Medical Commission of the UWW has been conducting comprehensive injury surveillance studies during wrestling competitions since 2008.²⁻⁴

The COVID-19 pandemic disrupted organised sports in all countries as authorities extensively modified, cancelled or postponed sporting participation as part of a strategy to reduce transmission of the virus during 2020–2021. Understanding the incidence and characteristics of injuries after the



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occurrence of the COVID-19 pandemic may help in comprehending the potential impacts of this condition and implementing more effective preventive measures during similar high-risk periods.⁵

This study aimed to document and compare the incidence and characteristics of wrestling injuries that occurred during two recent Olympic Games and evaluate the potential impact of the COVID-19 pandemic on injury rates and severity in elite adult wrestlers at the Tokyo Olympic Games.

METHODS

Study design

A cross-sectional study was conducted regarding injuries that occurred in wrestling competitions during the 2016 Rio and 2020 Tokyo Olympic Games. The Tokyo Olympic Games was held in August 2021 due to the COVID-19 pandemic.

Data sources

All wrestling injuries were recorded by direct observation of UWW sports physicians assigned to each wrestling mat during those competitions. For each injury, a UWW Injury Report Form was completed. Each form included the wrestler's name, identification number, nationality, sex, wrestling style, weight category, the severity of the injury, region and site of injury, type of injury, mechanism of injury, the position of the wrestler at the time of injury and the round that the injury occurred. During the Olympic Games, each wrestling style includes six different weight categories for the participating wrestlers: GR (60 kg, 67 kg, 77 kg, 87 kg, 97 kg, 130 kg), FS (57 kg, 65 kg, 74 kg, 86 kg, 97 kg, 125 kg) and WW (50 kg, 53 kg, 57 kg, 62 kg, 68 kg, 76 kg). Weight clusters are classified as low (the two lowest weight groups), middle (the two middleweight groups) and heavy (the two heaviest weight groups) for each category of competition.

Injury definitions and classifications

In this study, 'Injury' was defined as any physical or physiological harm or damage to the body that occurred during wrestling competitions and received medical attention regardless of consequences concerning absence from competition or training.⁶ This definition complies with the recommendations of the recent international consensus on the recording and reporting epidemiological data on sports injuries.⁷ This study, however, focused on injuries that occurred during wrestling competitions at the Olympic Games. Injuries that occurred during training sessions pre-match or post-match have not been included in this study.

All injuries were categorised into four main groups based on the severity of tissue damage and medical attention required to provide a compelling spectrum of injuries in the study. Mild injuries were defined as those treated primarily on the wrestling mat. Moderate injuries were identified as injuries that were treated primarily on the mat but required more attention after the match at the venue clinic or from the medical team. Severe injuries were defined as those by which the match had to be terminated, and the wrestler was transferred to the hospital.² Severe injuries that were life or limb-threatening were considered 'critical injuries'. In this study, a recurrent injury is defined as the same type of injury involving the same region before the Olympic Games.

In the UWW Injury Report Form, the main regions of wrestling injuries are divided into head, face, neck, thoracic spine, sternum, ribs, lumbar spine, abdomen, pelvis, shoulder girdle, upper arm, elbow, forearm, wrist, hand, thumb, fingers, hip, groin, thigh, knee, lower leg, ankle, foot and toes. The main types of wrestling injuries are classified as skin laceration, skin

contusion, nose bleeding, joint dislocation, ligament sprain, muscle strain, strangulation and concussion. For more accuracy, some injury sites and types are further subclassified. Mechanisms of wrestling injuries are classified as trauma (contact), non-contact trauma, violation of the rules, overuse, gradual onset and sudden onset. The positions of wrestlers during injury were classified as standing, parterre (lying flat on your stomach) and kneeling and timing was recorded according to which round the injury occurred, for example, repechage, finals. These classifications are based on injury surveillance data collected since the 2004 Athens Olympic Games.³

Confidentiality

We ensured athlete anonymity by treating all personal and medical information confidentially and de-identifying our database after the Games, prior to analysis.

Patient and public involvement

Athlete patients did not participate in planning or executing the study. Representatives of athletes will be consulted to interpret results and potential for future injury and illness prevention measures.

Equity, diversity and inclusion statement

Our study included male and female wrestlers from various countries and races who participated in the Olympic Games. Our group of authors comprised one woman and six men from different nationalities, including Canada, Uzbekistan, the UK, Serbia, Greece and Hungary. The authors also varied in age and professional backgrounds.

Data analysis

The incidence of injury in the two Olympic Games was assessed and reported individually as injury numbers, the proportion of total injuries and incidence based on the number of wrestlers at each Games. Injuries were assessed for severity, region and type in two Olympic Games, adjusted for wrestling styles and weight clusters (low, middle, heavy). The methodology adopted in this study has been effectively applied in several surveillance studies.^{2 8–10}

The univariate differences between groups were evaluated using χ^2 and Fischer's exact test and the OR was calculated with 95% upper and lower CIs. Statistical significance was established at the 5.0% significance level (p value < 0.05). Statistical analysis was performed by RStudio software V.2022.07.0 Build 548 2009–2022 RStudio, PBC.

RESULTS

A total of 346 qualified wrestlers from 68 countries competed in 410 matches in three styles (WW: 112, FS: 118 and GR: 116) during the Rio Olympic Games, while the Tokyo Games hosted 287 wrestlers from 60 countries participating in 322 matches in the three styles (WW: 96, FS: 95 and GR: 96). During 410 matches in the Rio Games, 21 injuries were recorded with 5.1 injuries/100 bouts and 6.1 injuries/100 athletes, while during 322 matches in the Tokyo Games, 28 injuries were recorded with 8.7 injuries/100 bouts and 9.8 injuries/100 athletes; however, these differences were marginally not statistically significant; (injuries/bout: p value = 0.057, 95% CI: 0.31 to 1.02), (injuries/athlete: p value = 0.087, 95% CI: 0.33 to 1.08).

Injury incidence by wrestling style

In the Rio Olympics, the highest proportion of injuries occurred in GR style (42.9%, 9 out of 21 injuries) with an incidence of 7.7 injuries/100 athletes (9 in 116), followed by FS-related injuries, with an injury proportion of 33.3% injuries (7 out of 21) and an incidence of 5.9 injuries/100 athletes (7 in 118). In the Tokyo Games, the most injuries occurred in FS wrestling (11 out of 28 injuries), corresponding to 39.3% of total injuries with an incidence of 11.6 injuries/100 athletes (11 in 95) and the GR style-related injuries with a proportion of 39.3% of injuries (11 out of 28) and an incidence of 11.5 injuries/100 athletes. WW had the lowest proportion of injuries, with 23.8% injuries (5 out of 21) and an incidence of 4.5 injuries/100 athletes (5 in 112) in the Rio Games and a proportion of 21.4% injuries (6 out of 28) and an incidence of 6.3 injuries/100 athletes (6 in 96) in the Tokyo Games. No athlete sustained more than one injury during the Rio or Tokyo Olympics.

During Rio competitions, 6.8% of male wrestlers experienced injuries, while injuries occurred in 4.4% of female wrestlers. The incidence of injuries for men and women in the Tokyo Games were 11.5% and 6.3%, respectively, which were higher than Rio Games; however, these differences were not statistically significant (injury difference Rio/Tokyo, men: OR: 0.56, *p* value=0.09, 95% CI: 0.29 to 1.11), (injury difference Rio/Tokyo, women: OR: 0.7, *p* value=0.57, 95% CI: 0.21 to 2.37). The injury rate between male and female athletes was not statistically significant (OR: 0.54, *p* value=0.08, 95% CI: 0.27 to 1.07). [Table 1](#) represents the combined information regarding wrestling injury specifications in the Rio and Tokyo Olympic Games.

Injury severity in the Rio and Tokyo Olympic Games

No critical injury was recorded during the Rio or Tokyo Games. In the Rio Games, 57% of injuries were mild, 24% were moderate and 19% were severe, while in the Tokyo Games, injury severity proportions were 75%, 14.3% and 10.7%, respectively ([table 1](#)). The injury severity rates between the Rio and Tokyo Olympic Games were not statistically significant (Rio/Tokyo, mild vs non-mild OR: 0.36, *p* value=0.11, 95% CI: 0.1% to 1.27% and Rio/Tokyo, severe vs non-severe OR: 1.96, *p* value=0.41, 95% CI: 0.39 to 9.9). The injury severity rate for each style in both Olympic Games is shown in [figure 1](#).

According to recorded data, no recurrent injuries were identified in the Rio Games. In contrast, in the Tokyo Games, one mild injury on the face, a skin laceration and one severe muscle strain on the thigh were identified as recurrent injuries.

Injury rate and severity—weight clusters

No significant difference was found between wrestling weight clusters and injury rates in the Rio and Tokyo Olympic Games. Integrating both Games, low-weight wrestlers accounted for the largest proportion of injuries compared with non-low-weight wrestlers (OR 0.026, *p* value=0.03, 95% CI: 0.08 to 0.87). No significant association was found between injury severity and weight groups (*p* value=0.51). However, on reviewing the injury severity observed in three different weight clusters in both Games, it is shown that most severe injuries involved low-weight wrestlers, followed by heavy-weight wrestlers. Also, severe injuries are assumed to be less likely in GR wrestling.

Injury region

In both the Rio and Tokyo Olympic Games, the head and face were the most prevalent regions of injury, with 76% and 71.2% of injuries, respectively, and an average of 73.5% overall. 83.3%

of head and face injuries were classified as mild, while moderate and severe injuries accounted for 13.9% and 2.8%, respectively. The second most affected region was the lower extremity, with 14.3% of all injuries. Lower extremity injuries were higher in the Tokyo Games (18% vs 9.6% in Rio). Although 10.2% of injuries were reported in the upper extremity, 80% of the injuries in this region were severe. No injury was recorded in the spine and trunk region in the Rio Games, while one injury was reported in the Tokyo competitions. [Table 2](#) summarises the injury severity in different regions, and [figure 2](#) demonstrates wrestling injury regions in two Olympic Games.

Injury type

Skin lacerations comprised the highest proportion of injury types, with 38.1% of injuries in the Rio Games and 39.2% in the Tokyo Games. Nose bleeding was the next most common type of injury, with 19% in the Rio Games and 10.7% of injuries in the Tokyo Games. The number of ligament sprains was equal in both Games (two injuries); however, no muscle strain was recorded in the Rio Games, while this type of injury comprised 14.3% of injuries in the Tokyo Games. Joint dislocations, classified as severe injuries, decreased from three (two shoulder and one elbow dislocations) in Rio to one shoulder dislocation in the Tokyo Games, and they were in FS (*n*=2) and WW (*n*=2) styles; no dislocation was recorded in GR wrestlers. One traumatic concussion was reported during the Tokyo Games, and one strangulation was recorded in the Rio Games. Overall, the severity of wrestling injuries was lower in the Tokyo Games. [Figure 3](#) demonstrates the distribution of injuries based on type, style and weight categories.

Time of injury

Regarding the timing of injuries, 38.7% of injuries in both Olympic Games occurred in the initial 1/8-final rounds of wrestling bouts ([table 1](#)). In the 1/2-final, final and repechage rounds, wrestlers experienced no severe injuries. Injuries in 1/8 finals were significantly higher than in other competition rounds (*p* value=0.04). The majority of injuries during both Olympic Games (83.6%) occurred in the morning sessions (1/16, 1/8, 1/4 and repechage), and only 16.4% of injuries happened during the afternoon sessions (semifinals and finals).

Mechanism of injury and position

Direct contact trauma has been the main mechanism of wrestling injuries in all three styles in both Olympic Games, around 81% and 82% in the Rio and Tokyo Games, respectively ([table 1](#)). Violation of rules was the least prevalent mechanism of injuries in both Olympics. In the Rio and Tokyo Olympics, most injuries (62% and 60.7%) occurred in a standing position ([table 1](#)). It should be noted that in both Olympic Games, the standing position resulted in the majority of mild injuries, while most of the severe injuries occurred in the parterre position.

DISCUSSION

Our data indicates that the majority of injuries sustained during the wrestling competitions at the 2016 Rio and 2020 Tokyo Olympic Games were mild skin injuries, primarily affecting the head and face regions. These injuries mostly occurred from direct contact during standing positions. Notably, no critical injuries were observed in either of these Olympic Games. However, attention should be focused on preventing upper limb joint dislocations, as they were common severe injuries in both events. Injury data from the Rio and Tokyo Olympic Games indicated

Table 1 Measures of injury in the Rio and Tokyo Olympic Games by style

		Rio Olympics				Tokyo Olympics			
		WW	FS	GR	%	WW	FS	GR	%
Injury count		5	7	9		6	11	11	
Athletes		112	118	116		96	95	96	
Injury/athlete		4.5%	5.9%	7.7%		6.3%	11.6%	11.5%	
Total matches		410				322			
Injury/bouts		5.1%				8.7%			
Total athletes		346				287			
Incidence		6.1%				9.8%			
Total injury		21				28			
Injury severity	Mild	3	3	6	57	3	10	8	75.0
	Moderate	0	2	3	24	1	0	3	14.3
	Severe	2	2	0	19	2	1	0	10.7
	Critical	0	0	0	0	0	0	0	0.0
Injury vs weight	Low	2	1	3	28.6	3	8	6	60.7
	Middle	2	4	4	47.6	3	1	3	25.0
	Heavy	1	2	2	23.8	0	2	2	14.3
Injury region	Face and head	3	4	9	76	3	8	9	71.2
	Upper extremity	1	2	0	14.4	1	1	0	7.2
	Lower extremity	1	1	0	9.6	1	2	2	18.0
	Spine and trunk	0	0	0	0	1	0	0	3.6
Injury type	Skin Laceration	0	4	4	38.1	0	6	5	39.2
	Skin contusion	2	0	1	14.3	2	1	3	21.4
	Bleeding	1	0	3	19.0	1	1	1	10.7
	Dislocation	1	2	0	14.3	1	0	0	3.6
	Ligament sprain	1	1	0	9.5	0	2	0	7.2
	Muscle strain	0	0	0	0	2	0	2	14.3
	Strangulation	0	0	1	4.8	0	0	0	0
	Concussion	0	0	0	0	0	1	0	3.6
Injury mechanism	Contact	4	5	8	81	6	8	9	82
	Non-contact	1	2	0	14.3	0	2	1	11
	Violation of rules	0	0	1	4.7	0	1	1	7
Position	Standing	1	4	8	62	2	7	8	60.7
	Parterre	4	2	0	28.6	3	2	1	21.4
	Kneeling	0	1	1	9.4	1	2	2	17.9
Injury vs timing	1/16	2	2	1	23.8	3	0	3	21.4
	1/8	3	4	4	52.4	2	3	3	28.6
	1/4	0	0	2	9.5	0	2	1	10.7
	1/2	0	1	1	9.5	0	1	1	7.1
	Repechage	0	0	1	4.8	0	2	3	17.9
	Finales	0	0	0	0	1	3	0	14.3
Injury/sex		Male		Female		Male		Female	
		6.8%		4.5%		11.5%		6.3%	
Injury	Athletes	16	234	5	112	22	191	6	96

FS, Freestyle wrestling; GR, Greco-Roman wrestling; WW, Women's wrestling.

that sex is not a risk factor for wrestling injuries, but wrestlers in lower weight categories are at a higher risk of injuries. Recording more wrestling injuries in the 1/8-final rounds in both Olympic Games highlights the need for more well-trained medical staff during the morning sessions. Although not statistically significant, the Tokyo Olympic Games, held after the COVID-19 pandemic, saw a higher incidence of injuries compared with the Rio Olympic Games.

Wrestling, being a contact sport, can result in various soft tissue and musculoskeletal injuries.^{11–13}

Although not statistically significant ($p=0.057$), higher injury frequency in the Tokyo Games compared with the Rio

Games might be related to the COVID-19 pandemic, potentially impacting the training and preparation process before the Olympic Games. Many lockdowns closed sports facilities and cancelled national and international training programmes. Postponed competitions due to the pandemic may explain the lower physical and mental preparation of athletes in the Tokyo Games. Bisciotti *et al* investigated the loss of efficiency of the neuromuscular system after a long detraining period such as that imposed by the COVID-19 pandemic.¹⁴ They suggested that a lack of specific stimuli for such a prolonged period may have deleterious effects on the neuromuscular system, exposing the players both to greater injury risk and a decrease in performance in soccer.

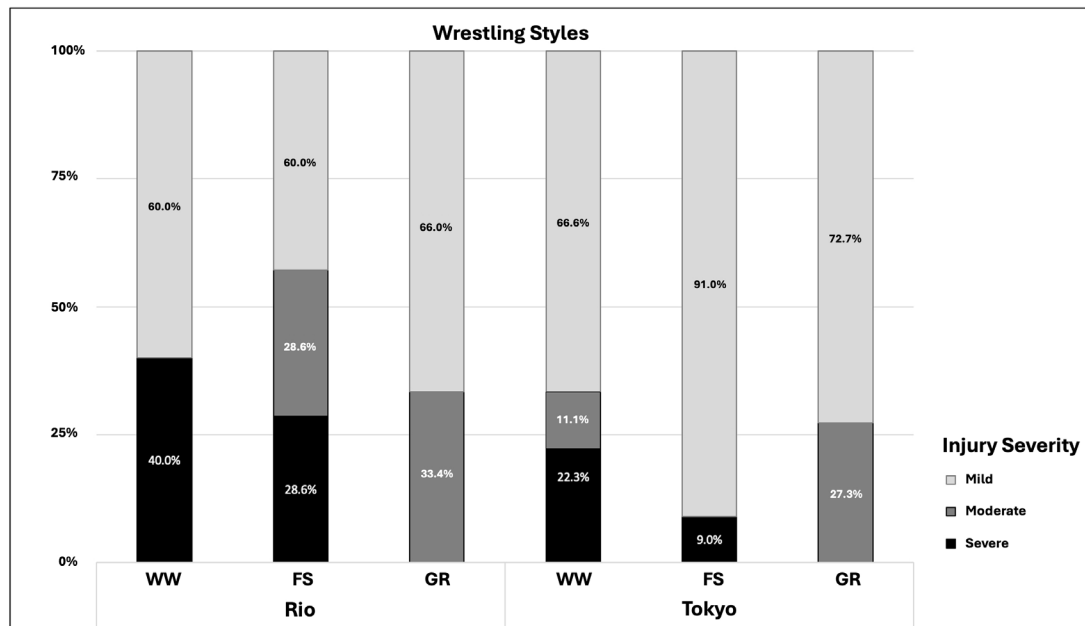


Figure 1 Injury severity according to style in two Olympic Games. FS, Freestyle wrestling; GR, Greco-Roman wrestling; WW, Women's wrestling.

Several studies evaluated wrestling injuries during training and competitive seasons at national levels.¹⁵ Estwanik *et al* reported the incidence of injuries to 26.5% during the USA Olympic wrestling trials, and Kersey and Rowan reported an injury rate of 31.2% during the 1980 National Collegiate Athletic Association wrestling championships.^{9 16} Our results demonstrate a significant decrease in injuries during the Rio and Tokyo Games compared with the collegiate wrestling championship reported by Kersey and Rowan.⁹ Differences in the experience and skill levels of the wrestlers, as well as gradual modification of wrestling regulations and banning some dangerous actions in recent years, may explain the lower incidence of injuries.

Although injury data from the Rio and Tokyo Olympic Games indicated slightly higher injury rates in male wrestlers than in female wrestlers, these differences were not statistically significant, indicating that sex is not a risk factor for wrestling injuries. Similar to our findings from the Rio and Tokyo competitions, Shadgan *et al* reported that sex was not a risk factor in the Beijing Olympic Games.² A comprehensive study of injuries among different team sports during the 2004 Olympic Games reported that overall injuries of male and female athletes were

not significantly different in incidence per 1000 player matches, location and circumstances.¹⁷

As expected, our results demonstrate that most injuries occurred in the head and face regions, and the remainder were in the upper and lower extremities. Wrestling is a full-contact sport; as a result, all body parts are vulnerable to injury. Head and face regions are commonly exposed to trauma in wrestling because of wrestling positions and techniques. In extremities, the knee, shoulder and ankle joints are reported to be the most commonly injured sites.^{2 18} Supposedly, using legs in FS/WW and hands and arms in GR make wrestlers more susceptible to lower and upper extremity injuries, respectively. It should be noted that although the upper extremity region had a lower number of injuries in total compared with the head, face and lower extremity region, around 57% of severe injuries occurred in this region, primarily due to joint injuries.

Small skin contusions and lacerations were the most common types of injury, followed by nose bleeding, ligament sprains and muscle strains. Skin lacerations mostly occurred in the head and face regions. The most common sites of ligament sprains were the ankle and knee joints. Wroble *et al* reported that the most

Table 2 Injury severity, based on injury region and injury site, in different wrestling styles

Injury region	Injury area	WW			FS			GR		
		Mild	Moderate	Severe	Mild	Moderate	Severe	Mild	Moderate	Severe
Head and face	Head	5	0	0	1	0	0	0	0	0
	Face	1	0	0	9	1	1	14	4	0
Upper extremity	Shoulder	0	0	2	0	0	1	0	0	0
	Arm	0	0	0	1	0	0	0	0	0
	Elbow	0	0	0	0	0	1	0	0	0
Lower extremity	Thigh	0	0	1	0	0	0	0	1	0
	Knee	0	0	1	1	1	0	0	0	0
	Ankle	0	0	0	1	0	0	0	0	0
	Foot	0	0	0	0	0	0	0	1	0
Spine and trunk	Lumbar	1	0	0	0	0	0	0	0	0

FS, Freestyle wrestling ; GR, Greco-Roman wrestling ; WW, Women's wrestling.

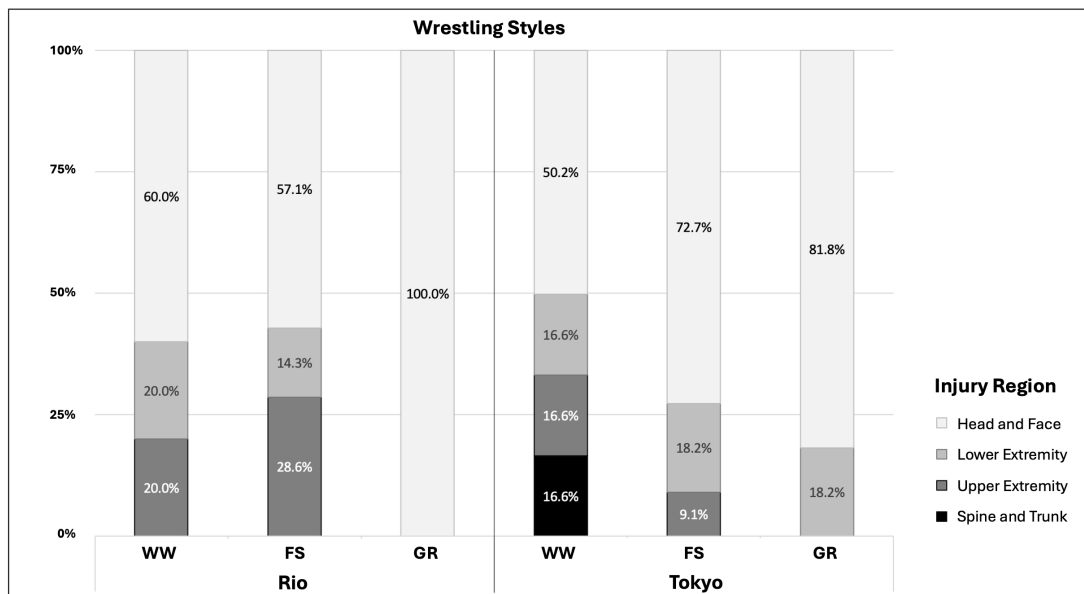


Figure 2 Injury region based on wrestling styles in two Olympic Games. FS, Freestyle wrestling; GR, Greco-Roman wrestling; WW, Women’s wrestling.

frequent knee injuries in collegiate wrestling include prepatellar traumatic bursitis, lateral and medial collateral ligament sprains and meniscal tears.¹⁸ In our study, muscle strains mainly occurred in the hamstring, lumbar spine and gastrocnemius muscles. Joint dislocations were classified as severe injuries and occurred in all past four Olympic Games, including two anterior glenohumeral dislocations and one posterior dislocation of the elbow in Rio and one anterior glenohumeral dislocation in the Tokyo Games. The constant occurrence of anterior shoulder dislocations in all Olympic Games and most world championships since 2004 (UWW Injury Surveillance Data) is concerning and requires improved preventative measures. Strengthening the rotator cuff and scapular stabilisers through a full range of movement can help reduce the risk of dislocation.¹⁹ Proactive and careful referees to stop the forceful external rotation of the

shoulder joint during wrestling can also reduce the incidence of this serious injury in wrestling.²⁰ This observation highlights the importance of having well-prepared and trained wrestling medical staff to manage upper limb dislocations.

Due to the differences in the definition of injury severity, estimate of time loss and the method of data collection, it is difficult to compare our data on injury severity with the International Olympic Committee consensus statement and other reports.^{7 21–23} Several studies have used the number of days lost because of injury or the number of days to return to full fitness as indicators of injury severity.^{16 21–23} Nevertheless, the extent of time off does not necessarily indicate the severity of the injury. The severity classification that we applied in this research was built on a practical method for categorising the level of injuries that occurred on the mat during a wrestling match. According to

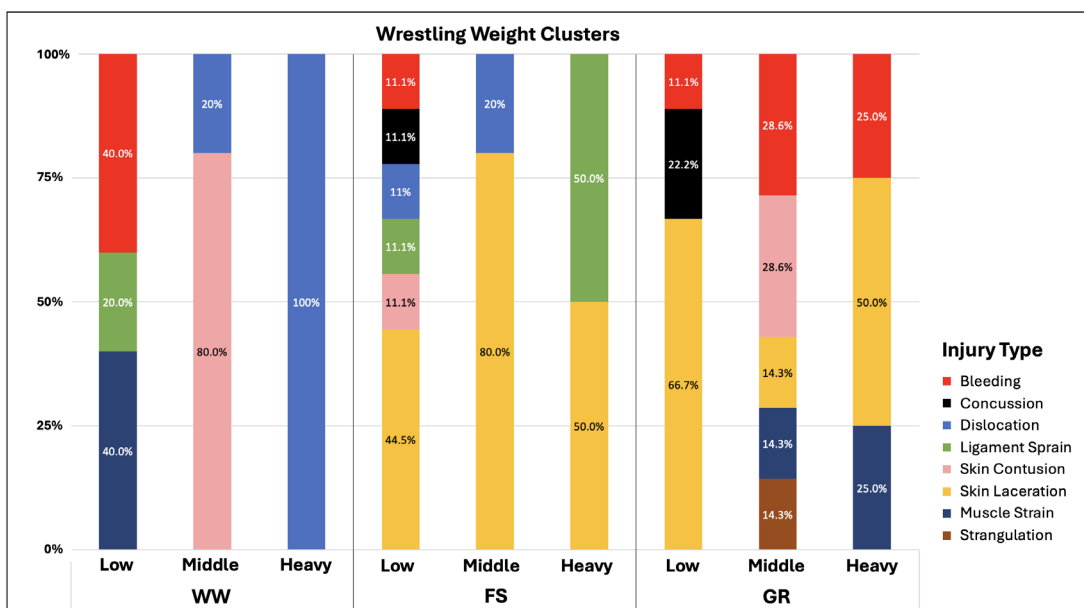


Figure 3 Injury type based on wrestling style and weight cluster, integrating the injuries from Rio and Tokyo wrestling Games. FS, Freestyle wrestling; GR, Greco-Roman wrestling; WW, Women’s wrestling.

our classification, many injuries were mild and did not require medical attention after the match. In GR style, wrestlers experienced no severe injury in the Rio or Tokyo Games. It is important to highlight that no critical injury was recorded during wrestling competitions of the last two Olympic Games.²

In wrestling, like in other contact sports, strains and sprains are common recurring injuries.¹⁰ This is mainly due to the nature of the sport, which involves a high degree of physical contact, explosive movements, repetitive motions and forceful joint manipulation. As a result, athletes are at risk of repetitive overextension, twisting injuries and overuse injuries. The intense grappling and explosive takedown manoeuvres in wrestling often cause a wrestler's joints to be in positions that can overstretch and distort or tear ligaments and muscles. Moreover, the repetitive motions involved in wrestling can lead to micro-tears and overuse injuries. The knee, shoulder, ankle and fingers are the most frequently affected body areas for recurrent injuries.^{10 18}

Regarding injury mechanisms, direct, forceful body contact, using legs and arms as levers and falling and twisting joints were responsible for most injuries during wrestling competitions in the Rio and Tokyo Games. Most injuries happened during the standing position when two wrestlers engaged for a takedown and collided with their heads and faces. The nose, eyebrows, lips and chin are more vulnerable to direct trauma. Overtwisting of shoulder and elbow joints was also a mechanism of injury during the Rio and Tokyo Games, resulting in four severe joint dislocations. All four joint dislocations happened while wrestlers were in the parterre position.

Most studies on wrestling injuries did not find a statistically significant difference among the weight categories.^{2 8 22 24} However, our study's injury rates were significantly higher ($p=0.03$) in low-weight wrestlers. It should be noted that in the women's heavy-weight group, although overall injuries were lower than in low-weight classifications, all injuries were severe.

We studied the timing of injuries during the wrestling competitions in the Rio and Tokyo Olympic Games and realised that most injuries occurred in the 1/8-final round of wrestling bouts in morning sessions. 57% of the severe injuries occurred at this stage. These findings may result from the effort and pressure that wrestlers experienced to reach the higher rounds. Alternatively, it could be due to the potential mismatch in strength and power between opponents in the earlier rounds. Meanwhile, wrestlers in the 1/2-final, final and repechage rounds experienced no severe injuries. This highlights the need to have a sufficient number of well-trained medical staff present during the morning sessions to ensure prompt and effective medical attention. A significant mismatch in strength and power between opponents may also increase the risk of injuries during initial rounds. Using further caution and protection in higher rounds as wrestlers get closer to the final stages may explain this discrepancy.

Strengths and limitations

This study is the first to compare the incidence of wrestling injuries in two consecutive Olympic Games using an accurate injury surveillance system. It is also a unique study that investigates the potential effects of the COVID-19 pandemic on Olympic wrestling injuries. Although this research has some strengths, there are also some limitations that need to be considered. This study did not investigate wrestlers who had previously contracted COVID-19 before participating in the Tokyo Olympic Games. As a result, we were unable to analyse the potential influence of COVID-19 on wrestling injuries and the

duration of return-to-play.²⁵ The study was restricted to injuries that occurred during wrestling matches and required medical attention, regardless of the implications for return to training or competition. The study's scope may be expanded by taking an accurate history of training-related and past injuries; however, it was not feasible to monitor training-related injuries that could even occur before entering the competitions by the UWW medical team. Furthermore, injury rates per athlete exposure and per duration of the competition and practice could not be calculated since there was no data regarding training sessions. Due to injured competitors not being monitored after the Games, time-lost classifications for injury severity and return-to-play information of injured wrestlers were not established. It should be noted that the number of participants and wrestling weight classes in the Olympic Games is limited compared with national and international competitions; as a result, the number of injuries in each style and weight category was low. This may result in the low power of the study, limited statistical significance and type II errors. Future research that includes follow-up with injured athletes can broaden our understanding of injury burdens on athletes' health and performance. Finally, cross-sectional studies on sports injuries have distinct strengths and limitations. While they offer a quick snapshot of injury occurrences and patterns in a large population at specific time points, they can only identify associations, not causality. This is because data on exposure and outcome are collected simultaneously. Moreover, the data is limited to the time frame of the competitions and might not reflect injury risks during training or over an athlete's career.

Recommendations and implications

It is crucial to recognise the nature and risk factors of sport-specific injuries and implement preventive measures and additional regulations to reduce the incidence and severity of sports injuries. This highlights the critical importance of continuous and thorough surveillance of injuries during major sporting events such as the Olympic Games and World Championships. The findings of this study also underscore the necessity for well-trained medical personnel to manage common injuries during wrestling competitions efficiently. Remarkably, considering the occurrence of upper limb joint dislocations, which are considered severe injuries in wrestling, further attention should be drawn to the prevention of joint dislocations and their management during wrestling competitions.

The COVID-19 pandemic posed unprecedented challenges for high-performance athletes, such as disruptions of regular training programmes and preparation processes and a higher level of stress. While many athletes infected with COVID-19 experienced mild or no symptoms and were able to return to play within a few weeks, 10–15% of athletes suffered from prolonged symptoms that hindered their ability to function and exercise for several weeks or even months.²⁵ For elite athletes preparing for potential future pandemics, evidence-based observations suggest adhering to public health guidelines to reduce infection risk,^{26 27} adjusting training routines to account for limited access to facilities,²⁸ practicing mindfulness to maintain mental resilience,²⁸ staying connected with coaches and teammates virtually,²⁸ maintaining proper nutrition and hydration²⁹ and staying up-to-date with vaccination and booster shots as recommended by health authorities to mitigate health risks and sustain performance levels.³⁰

CONCLUSION

During the Rio and Tokyo Olympic Games, the rate of wrestling injuries was 6.1 and 9.8 injuries/100 athletes, respectively. Our data analysis from the last two Olympic Games indicates that most wrestling injuries were mild skin injuries that occurred in the head and face regions due to direct body contact during standing positions in the initial rounds of wrestling competitions. Wrestlers in FS and WW styles at lower and higher weight categories in the parterre position are at higher risk of severe injuries in Olympic wrestling. No critical injury was observed during the recent Olympic Games. Although not statistically significant, the higher occurrence of injuries in the Tokyo Games compared with the Rio Games can possibly be explained by the occurrence of the COVID-19 pandemic in 2020.

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