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Uncovering risk factors for sports injuries in elite wrestlers: a multivariable analysis

Emirhan Demirhan[1], Ayça Genç[2*], Bilal Demirhan[3]

[1] Graduate Education Institute, Bartin University, Bartin, Turkey.

[2] Faculty of Sports Sciences, Bartin University, Bartin, Turkey.

[3] Kyrgyzstan Türkiye-Manas University, Bishkek, Kyrgyzstan.

* Correspondence: Ayça Genç; aycagenc@bartin.edu.tr

ABSTRACT

Wrestling is a sport that involves intense physical contact and high levels of exertion, which means it carries various injury risks for athletes. This study aimed to examine the types of sports injuries among elite male and female wrestlers in Turkey according to different variables. A descriptive cross-sectional design was employed, using a 31-item questionnaire comprising 18 personal and 13 injury-related questions. The study included 169 elite wrestlers from Turkey: 54 freestyle (32.0%), 56 Greco-Roman (33.1%), and 59 female wrestlers (34.9%). Knee and shoulder injuries were the most frequently reported, with knee injuries predominating among Greco-Roman (18.0%) and female wrestlers (24.3%), and shoulder injuries among freestyle wrestlers (17.4%). Inadequate warm-up is the leading cause for men; excessive strain for women. Recurrent injuries were common (66.7–72.9%). Significant differences between wrestling styles were found in knee ($p=0.017$), ear ($p=0.009$), leg ($p=0.016$), and foot injuries ($p=0.024$), with no significant differences in other injury locations ($p>0.05$). The study concludes that the risk of injury varies depending on factors such as wrestling style and gender, and that preventive measures should be planned with these differences in mind.

KEYWORDS

Sports Medicine; Wrestling; Injury; Risk Factor

1. INTRODUCTION

Current research in wrestling focuses on enhancing sports efficiency, injury prevention, protective health measures, fitness, and performance. Due to the intense loads and contact nature of wrestling, elite athletes frequently experience sports injuries.

Injuries in sports are classified as mild, moderate, severe, and critical based on severity (Molnar et al., 2022). Factors such as frequent contact, inadequate preparation, loss of concentration, improper loads, diet, and weight loss contribute to injuries. Wrestling styles (Freestyle, Greco-Roman) also influence injury severity and affected areas (Kim & Park, 2021).

The knee joint is the most commonly injured area in wrestling, due to incorrect technique, lower extremity overload, violent falls, and bearing both wrestlers' weight on one leg. Face, shoulder, ankle, and neck injuries are also frequent (Atay et al., 2007; Holloran, 2008). Injury frequency and severity can be reduced through proper precautions and prevention programs, reflecting society's growing awareness of injury prevention. These programs focus on reducing the incidence of injury by changing the effect of risk factors thought to be associated with injury (Ercan & Önal, 2021).

This study aims to examine the types of sports injuries among elite male and female wrestlers in Turkey according to different variables. It is expected that the findings will contribute to the existing literature by informing preventive measures aimed at minimizing sports injuries among wrestlers.

2. METHODS

2.1. Participants

The study included 169 national wrestlers (54 freestyle, 56 Greco-Roman, 59 female) and used a descriptive screening model to examine sports injuries (Karasar, 2012). The survey consisted of 18 personal and 13 injury-related questions. Participation was voluntary, and the study was approved by the Bartın University Social and Human Sciences Ethics Committee (Decision No. E-23688910-050.01.04-2300000107).

2.2. Procedure

Data were collected using a structured questionnaire administered to national-level wrestlers actively competing in Turkey. Before completing the questionnaire, participants were informed about the purpose of the study and the voluntary nature of their participation. The questionnaire gathered information about participants' demographic and sporting characteristics, as well as their previous

sports injuries, including injury types, anatomical locations, causes, and treatment history. Participants completed the questionnaire voluntarily, and the collected responses were organized for statistical analysis.

2.3. Statistical Analyses

The research data were analyzed using SPSS 25.0. Frequency and percentage calculations were performed, and differences between injury areas and wrestling styles were determined using Chi-Square analysis, with a significance level of $p<0.05$.

3. RESULTS

The research involved 169 wrestlers (freestyle, n = 54; Greco-Roman, n = 56; women, n = 59). The average ages were 25.22 years for freestyle, 24.19 for Greco-Roman, and 23.61 for women wrestlers. Average body weights were 80.64 kg for freestyle, 78.28 kg for Greco-Roman, and 59.05 kg for women wrestlers.

The vast majority of wrestlers participating in the study have national athlete status (94.4% freestyle; 76.8% Greco-Roman; 91.5% women). A significant proportion of all wrestlers have won medals at the international level. Additionally, freestyle and Greco-Roman wrestlers train five days a week, while women wrestlers train six days a week, and nearly all athletes train in two sessions per day.

Table 1. Frequency analysis of recurrent injuries and injury count in wrestlers

		Freestyle		**Greco-Roman**		**Women**	
		f	**%**	**f**	**%**	**f**	**%**
Number of injuries	1 injur	10	18.5	7	12.5	6	10.2
	2 injuries	7	13.0	7	12.5	12	20.3
	3 injuries	8	14.8	11	19.6	15	25.4
	4 injuries	9	16.7	5	8.9	5	8.5
	5 < injuries	20	37.0*	26	46.4*	21	35.6*
	Total	54	100.0	56	100.0	59	100.0
Repetitive injury to the same area	Yes	36	66.7	39	69.6	43	72.9
	No	18	33.3	17	30.4	16	27.1
	Total	54	100.0	56	100.0	59	100.0

The results indicate that most wrestlers in all three categories reported five or more injuries, particularly Greco-Roman wrestlers (46.4%). Recurrent injuries to the same body area were also common, reported by 66.7% of freestyle wrestlers, 69.6% of Greco-Roman wrestlers, and 72.9% of

women. Table 2 shows the distribution of sports injuries across different body areas among the three wrestling categories.

Table 2. Frequency analysis of sports injury areas

		Freestyle		Greko-Romen		Women	
		f	%	f	%	f	%
Injury Areas	Knee	26	14.6	38	18.0*	43	24.3*
	Shoulder	31	17.4*	32	15.2	27	15.3
	Waist	17	9.6	13	6.2	18	10.2
	Back	10	5.6	7	3.3	5	2.8
	Hip	5	2.8	4	1.9	5	2.8
	Groin	9	5.1	14	6.6	8	4.5
	Ear	17	9.6	29	13.7	15	8.5
	Leg	17	9.6	8	3.8	7	4.0
	Elbow	26	14.6	30	14.2	23	13.0
	Foot	17	9.6	32	15.2	25	14.1
	None	3	1.7	4	1.9	1	0.6
	Total	178	100.0	211	100.0	177	100.0

Knee injuries were the most frequent among Greco-Roman wrestlers (18.0%) and women (24.3%), while shoulder injuries were most common among freestyle wrestlers (17.4%). Elbow and foot injuries were also relatively frequent across all groups. Overall, the findings indicate that the knees, shoulders, elbows, and feet are the most commonly affected body areas. Figure 1 presents the injury areas and rates according to wrestling styles.

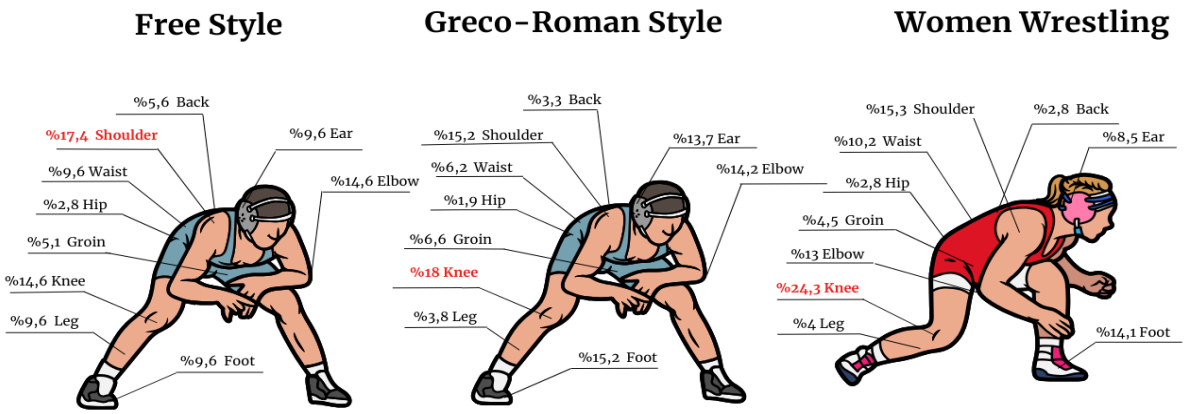


Figure 1. Injury areas and rates according to wrestling styles

Table 3 shows the distribution of surgical procedures following sports injuries. Knee surgery was the most frequently reported across all three categories, particularly among women (29.0%), followed by Greco-Roman (17.2%) and freestyle wrestlers (16.4%).

Table 3. Frequency analysis of areas where surgery was performed after sports injury

		Freestyle		**Greco-Roman**		**Women**	
		f	**%**	**f**	**%**	**f**	**%**
Post-injury surgery	Knee	9	16.4*	11	17.2*	18	29.0*
	Shoulder	6	10.9	5	7.8	4	6.5
	Waist	2	3.6	3	4.7	-	-
	Hip	-	-	2	3.1	-	-
	Groin	1	1.8	1	1.6	1	1.6
	Leg	4	7.3	-	-	1	1.6
	Elbow	5	9.1	6	9.3	4	6.5
	Foot	4	7.3	2	3.1	1	1.6
	Ear	3	5.4	1	1.6	2	3.2
	None	21	38.2	33	51.6	31	50.0
	Total	55	100.0	64	100.0	62	100.0

However, most participants reported having no surgery, especially Greco-Roman wrestlers (51.6%) and women (50.0%). These findings indicate that the knee was the most common site requiring surgical intervention. Table 4 presents the analysis results of sports injury causes and periods.

Table 4. Frequency analysis of sports injury causes and periods

		Freestyle		**Greco-Roman**		**Women**	
		f	**%**	**f**	**%**	**f**	**%**
Causes of injury	Incomplete warm-up	20	37.0*	21	37.5*	19	32.2
	Incorrect technique	7	13.0	5	8.9	4	6.8
	Lack of training	3	5.6	3	5.4	2	3.4
	Overload	19	35.2	21	37.5	29	49.2*
	Inadequate nutrition	-	-	-	-	2	3.4
	Lack of concentration	3	5.6	6	10.7	2	3.4
	Excessive weight loss	2	3.7	-	-	1	1.7
	Total	54	100.0	56	100.0	59	100.0
Training periods where injuries occur	General preparation period	23	42.6*	24	42.9*	12	20.3
	Special preparation period	11	20.4	5	8.9	13	22.0
	Special preparation period	18	33.3	21	37.5	27	45.8*
	Off-season	2	3.7	6	10.7	7	11.9
	Total	54	100.0	56	100.0	59	100.0

Table 4 shows that incomplete warm-up was one of the leading reported causes of injuries among freestyle (37.0%) and Greco-Roman wrestlers (37.5%), while overload was the most common cause among women (49.2%). Regarding training periods, injuries occurred most frequently during general preparation among freestyle (42.6%) and Greco-Roman wrestlers (42.9%), whereas women reported the highest frequency during the special preparation period (45.8%). Table 5 shows the distribution of bone fractures among the three wrestling categories.

Table 5. Frequency distribution analysis of bone fractures associated with sports injuries

Fractures	Freestyle		Greco-Roman		Women	
	f	%	f	%	f	%
Cheekbone	5	15	5	18.5	5	25.0
Nose	7	21.2	7	25.9	5	25.0
Skull	1	3	-	-	1	5.0
Rib	9	27.3*	4	14.8*	-	-
Finger	8	24.2	8	29.6	8	40.0*
Tibia	1	3	2	7.4	-	-
Heel	1	3	-	-	-	-
Toe	1	3	1	3.7	1	5.0
Total	33	100.0	27	100.0	20	100.0

It was determined that rib fractures were most frequent among freestyle wrestlers (27.3%), followed by finger fractures (24.2%), while finger fractures were the most common among Greco-Roman wrestlers (29.6%). Among women wrestlers, finger fractures were also the most frequent (40.0%). Table 6 presents the frequency and distribution of muscle injuries across different body regions among freestyle, Greco-Roman, and women wrestlers.

Table 6. Frequency analysis of sports-related muscle injuries

Body regions	Freestyle		Greco-Roman		Women	
	f	%	f	%	f	%
Shoulder Muscles	20	74.1*	25	67.6*	17	63.0*
Neck Muscles	2	7.4	1	2.7	-	-
Abdominal Muscles	1	3.7	1	2.7	-	-
Upper Leg Muscles	3	11.1	3	8.1	4	14.8
Arm Muscles*	-	-	2	5.4	4	14.8
Arm Muscles	-	-	3	8.1	-	
Chest Muscles	1	3.7	2	5.4	2	7.4
Total	55	100.0	37	100.0	27	100.0

Table 6 shows that shoulder muscle injuries were the most frequent across all wrestling styles, accounting for 74.1% of injuries among freestyle wrestlers, 67.6% among Greco-Roman wrestlers, and 63.0% among women wrestlers. Upper leg muscle injuries were also reported, representing 11.1%, 8.1%, and 14.8%, respectively. Table 7 presents the frequency and percentage distribution of ligament injuries and joint dislocations across six body regions (wrist, ankle, shoulder, hip, Achilles tendon, and knee) among wrestlers competing in freestyle, Greco-Roman, and women's wrestling.

Table 7. Frequency analysis of ligament injuries and joint dislocations in wrestlers

Body regions	Styles	Ligament rupture		Ligament tear		Sprain		Dislocation	
		f	%	f	%	f	%	f	%
Wrist	Free style	4	44.4	2	6.1	8	29.6	4	57.1
	Greco-Roman	-	-	6	18.8	14	28.6	1	12.5
	Women	3	21.4	5	17.9	9	27.3	2	14.3
Ankle	Free style	-	-	3	9.1	8	29.6	-	-
	Greco-Roman	1	12.5	3	9.4	11	22.4	1	12.5
	Women	2	14.3	5	17.9	17	51.5	1	7.1
Shoulder	Free style	1	11.1	10	30.3	2	7.4	1	14.3
	Greco-Roman	-	-	8	25.0	1	2.0	-	-
	Women	1	7.1	4	14.3	1	3.0	4	28.6
Hip	Free style	-	-	2	6.1	1	3.7	-	-
	Greco-Roman	1	12.5	-	-	2	4.1	-	-
	Women	-	-	-	-	-	-	1	7.1
Achilles Tendon	Free style	1	11.1	1	3.0	3	11.1	2	28.6
	Greco-Roman	1	12.5	-	-	7	14.3	5	62.5
	Women	-	-	1	3.6	4	12.1	3	21.4
Knee	Free style	3	33.3	11	33.3	2	7.4	-	-
	Greco-Roman	3	37.5	15	46.9	2	4.1	1	12.5
	Women	8	57.1	12	42.9	1	3.0	2	14.3

According to the table above, ligament injuries in wrestlers are most commonly seen in the knee and shoulder regions. In women wrestlers, the rates of knee ligament rupture (57.1%) and ankle sprain (51.5%) are noteworthy. In Greco-Roman, knee ligament tears (46.9%) are prominent, while in freestyle, shoulder ligament tears (30.3%) are prominent. Dislocations are concentrated in the wrist (57.1%) in freestyle and in the Achilles tendon (62.5%) in Greco-Roman. Table 8 presents the chi-square analysis results for sports injury areas according to wrestling styles.

Table 8. Chi-square analysis results for sports injury areas according to wrestling styles

		Styles			Total	Sd	x^2	p
		Freestyle	Greco-Roman	Women				
Knee	Yes	28	18	16	62	2	**8.170**	**0.017***
	No	26 [b]	38 [a]	43 [a]	107			
Shoulder	Yes	23	24	32	79	2	2.044	0.360
	No	31	32	27	90			
Waist	Yes	37	43	41	121	2	1.122	0.571
	No	17	13	18	48			
Back	Yes	44	49	54	147	2	2.532	0.282
	No	10	7	5	22			
Hip	Yes	49	52	54	155	2	0.166	0.920
	No	5	4	5	14			
Groin	Yes	45	42	51	138	2	2.660	0.265
	No	9	14	8	31			
Ear	Yes	37	27	44	108	2	**9.388**	**0.009***
	No	17 [b]	29 [a]	15 [b]	61			
Leg	Yes	37	48	52	137	2	**8.248**	**0.016***
	No	17 [a]	8 [b]	7 [b]	32			
Elbow	Yes	28	26	36	90	2	2.519	0.284
	No	26	30	23	79			
Foot	Yes	37	24	34	95	2	**7.428**	**0.024***
	No	17 [b]	32 [a]	25 [a]	74			

Note. *(a-b) Different letters on the same line indicate significance*

Knee injury rates were similar in Greco-Roman and women ($p>0.05$), but both had more knee injuries than freestyle wrestlers ($p<0.05$). Greco-Roman wrestlers had significantly more ear fractures ($p<0.05$). Leg and foot injuries were similar between Greco-Roman and women ($p>0.05$), but less common in freestyle ($p<0.05$). No significant differences were found in other injury areas ($p>0.05$).

4. DISCUSSION

Wrestling, as a contact sport, involves elements that can lead to injury, such as throws and collisions (Grindstaff & Potach, 2006). Our study examined the injury profiles of 169 elite female, freestyle, and Greco-Roman wrestlers, many of whom were national and international medalists.

Athletes in the three styles of freestyle, Greco-Roman and women's wrestling generally train twice a day, reflecting a high level of training load. The fact that most participants have won medals at international level supports the link between intensive training and elite performance. These

findings align with Tunca (2019), emphasizing the importance of repetition in training for success in wrestling (Peukert et al., 1993).

According to frequency analysis (Table 1), a significant proportion of all wrestler groups have suffered five or more injuries during their careers. This finding suggests that high training loads and competition frequency in elite athletes may increase the risk of chronic and repetitive injuries. This aligns with similar studies, such as Kim & Park (2021) with 914 injuries among 340 athletes, and Park et al. (2019) with 1779 injuries among 313 wrestlers. Other research (Shadgan et al., 2010; Halloran, 2008; Thomas & Zamanpour, 2018) supports these findings, highlighting how frequent, intense training for elite wrestlers (Chaabene et al., 2017; Thomas & Zamanpour, 2018) likely contributes to the high injury rates.

Our study also examined the body regions where wrestlers suffered injuries and the recurrence of these injuries (Table 2, Figure 1). The findings show that injuries are both common and recurrent in certain anatomical regions (e.g., knee, shoulder, and lower back). This suggests that the high-contact and repetitive movements inherent in wrestling may cause chronic strain in specific areas. Previous research reported recurrence rates of 21.9% in wrestlers (Shadgan et al., 2010); 56.6% in female wrestlers (Köse, 2021), with the knee and shoulder being the most affected areas (Swenson et al., 2009). Mohammed (2019) confirmed the recurrence of sports injuries, emphasizing that resuming intense training prior to full recovery may result in re-injury, a finding also supported by Ergen (2002). Wrestling, a high-contact sport, carries a significant injury risk (Chaabene et al., 2017; Thomas & Zamanpour, 2018). Studies report similar findings, with the knee, shoulder, and lower back frequently injured (Atay et al., 2017; Akhmedov et al., 2016; Park et al., 2019), reflecting the high injury risk inherent to the sport (Taşkın, 2023).

In our study (Table 3), it was determined that the knee was the region most frequently subjected to surgical intervention in all wrestling styles, followed by the shoulder and elbow regions. This finding shows that the knee joint is the region most exposed to mechanical stress during wrestling due to both load bearing and sudden changes in direction. A lot of studies have similarly found that knee injuries, especially meniscus tears, commonly require surgery in wrestlers (Ford et al., 2023; Agel et al., 2007). The high surgery rates for knee injuries can be attributed to the demands of rotation and contact during wrestling (Jarret et al., 1998).

According to the frequency analysis presented in Table 4, the most common cause of injury in freestyle and Greco-Roman wrestlers is insufficient warm-up, while in female wrestlers, overexertion

is the main cause, followed by insufficient warm-up. In the same table, when examining the periods in which injuries most frequently occur, it is observed that freestyle and Greco-Roman wrestlers typically sustain injuries during the general preparation period, while female athletes experience the highest number of injuries during the competition period. These findings indicate that injury risks vary depending on gender and training phase, highlighting the importance of tailoring preventive measures based on the phase and style of training. Similar findings were reported by Tunca (2019); Kordi et al. (2012). Overall, our results align with the literature, identifying excessive strain, insufficient warm-up, incorrect techniques, and risk-taking as key risk factors for injuries. These results align with findings for male wrestlers but differ from previous research on female athletes. The differences may stem from variations in athletic level, age, and experience. Overall, most injuries occurred during the competition and general preparation periods, consistent with other research (Boden et al., 2002; Kabak et al., 2017).

According to Table 5, the most common type of fracture in freestyle wrestlers is rib fractures, while finger fractures are more common in Greco-Roman and female wrestlers. This difference may be due to the varying areas of stress on the body caused by the techniques specific to each wrestling style. For example, the intensity of attacks targeting the lower extremities in freestyle wrestling may result in more impact on the torso, while upper body contact and hand control in Greco-Roman wrestling increase the risk of trauma to the hands and fingers. From this perspective, the development of style- and gender-specific protective strategies becomes increasingly important. Sprains and fractures were frequently reported injuries (Hammami et al., 2018; Kabak et al., 2017). The correlation between fractures, age, experience, and injury history (Kordi, 2012) aligns with our athletes' profiles, supporting our findings.

The most common ligament injuries in all wrestling styles occur in the shoulder region, followed by muscle injuries in the upper leg muscles. This situation can be attributed to the nature of wrestling, particularly the high degree of load bearing and repetitive strain on the shoulder joint. Similarly, the upper thigh muscle groups are also prone to injuries due to intense muscle activity during actions such as pushing, pulling, and sudden changes in direction. These common injury areas, which occur regardless of style, highlight the need to place special emphasis on regional strengthening and protective exercises in training programmes. In a study conducted by Ford et al. (2023), a total of 135 basic injuries were identified in 74 wrestlers, with ligament injuries accounting for 53% of these cases. In a study conducted by Alabacak (2009), cases of muscle rupture and muscle tear in the shoulder region were found among athletes with disabilities; these injuries were reported

to occur at rates of 4.34% and 8.69%, respectively. The same study reported that tears in the arm muscles were detected in 13.04% of athletes. These findings indicate that upper extremity muscle groups are at high risk in contact sports such as wrestling.

According to Table 7, ligament injuries are most commonly seen in the knee and shoulder regions. Knee ligament ruptures and ankle sprains are notable in female wrestlers, while knee ligament tears are prominent in Greco-Roman wrestlers and shoulder ligament tears are prominent in freestyle wrestlers. Additionally, wrist dislocations are more common in freestyle wrestling, while dislocations around the Achilles tendon are more prevalent in Greco-Roman wrestling. These differences indicate that technical and loading differences between wrestling styles and genders influence the localization of joint injuries. Another study identified a total of 135 primary injury cases among 74 wrestlers, with 53% of these being ligament injuries (Ford et al., 2023). Kolukısa et al. (2018), who examined the injury conditions of wrestling athletes, found that dislocation injuries were most commonly experienced as shoulder dislocations. The results of many studies (Kordi et al., 2012; Hammami et al., 2018; Şensoy et al., 2021) align with the dislocation findings in joint injuries identified in our study.

According to the chi-square analysis in Table 8, there was no significant difference in knee and leg injury rates between Greco-Roman and female wrestlers ($p>0.05$); however, both groups experienced these injuries more frequently than freestyle wrestlers. On the other hand, it was determined that ear and foot injuries were significantly more common among Greco-Roman wrestlers than among both female and freestyle wrestlers. These findings suggest that the technical structure of the Greco-Roman style may cause more trauma to certain body parts. It is clear that style-based differences must be taken into account when developing specific interventions to protect athletes. A study on 340 wrestlers (Kim & Park, 2021) reported 914 injuries, similar to our findings of 566 injuries among 169 athletes. Another study on elite Korean wrestlers found 1779 injuries among 313 athletes (Park et al., 2019). Overall, injury rates between male and female wrestlers were not significantly different, consistent with other research (Shadgan et al., 2010; Hammami et al., 2018).

5. CONCLUSIONS

The results showed that shoulder injuries were more common in freestyle wrestling, while knee injuries were more common in Greco-Roman wrestling and women's wrestling. Insufficient warm-up was the main cause of injury in freestyle and Greco-Roman wrestling, while excessive

strain was the main cause of injury in women's wrestling. The prevalence of repetitive injuries in all groups highlights the importance of style- and gender-specific preventive approaches.

In this context, injury prevention strategies recommend that coaches develop scientific and individualised injury prevention programmes, and that sports health professionals implement early diagnosis and intervention strategies for athletes at risk. In this regard, the implementation of preventive approaches based on multidisciplinary cooperation is of great importance for the sustainability of athletic performance.

However, the fact that the study was limited to Turkish elite wrestlers and that the data was collected through self-reporting limits the generalisability of the findings. Future studies should include longitudinal and multi-centre research involving athletes from different countries and levels.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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