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Epidemiology of Judo-Related Injuries in 21 Seasons of Competitions in France

A Prospective Study of Relevant Traumatic Injuries

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Background: Judo is a full-contact fighting sport that may lead to severe injuries. There are limited data available on the incidence of judo-related injuries. The French Judo Federation has established a surveillance system to document the frequency and type of injuries during judo competitions.

Purpose: To describe the incidence rates and types of judo-related traumatic injuries during 21 seasons of competitions in France with respect to athlete (judoka) age, sex, and level of performance.

Study Design: Descriptive epidemiology study.

Methods: Between 1993 and 2014, each physician in charge of each judo competition filled out a form in which he/she documented the number of competing judokas, the number of fights, the number of medical interventions, the specific type of traumatic injuries for each intervention, the number of fight interruptions, and the number of athletes removed from the competition venue because of an injury. The age, sex, and level of performance of each judoka were also documented. Variance analysis was applied to assess whether differences in incidence rates of injuries between groups were significant (Student *t* test and chi-square test).

Results: Surveillance of 421,670 fights demonstrated 3511 injuries in 316,203 judokas (incidence proportion, 1.1%). Among the injuries recorded, the most common were sprains (54.3%), fractures (15.6%), and dislocations (12.5%). Female athletes exhibited significantly higher incidence rates for knee sprains and elbow dislocations, whereas male athletes exhibited a higher incidence rate for shoulder dislocations ($P < .001$ for all). Regarding age, higher incidence rates were observed in young adults (aged 18-20 years) for acromioclavicular sprains and in children (aged 10-14 years) for clavicle fractures compared with adults (aged 21-35 years) ($P < .001$ for both). Both young adult and adult athletes had a higher incidence rate of shoulder dislocations ($P < .001$). Regarding the level of performance, athletes competing at higher levels had a higher incidence rate of sprains to the knee ($P < .001$).

Conclusion: During 21 years of surveillance of injuries in judo competitions in France, the incidence proportion of injuries was 1.1%. Significant differences in incidence rates demonstrated when considering age, sex, and level of performance may help in developing strategies to prevent traumatic injuries in the future.

Keywords: epidemiology; sprain; fracture; dislocation; judo

Judo was founded in 1882 by Japanese Jigoro Kano from various aspects of jiu-jitsu. In the first years, judo was mainly practiced in Japan. Today, judo is one of the most well known of the martial arts and is practiced in over 150 countries worldwide.²² At the 2012 Olympic Games in London, 383 athletes (judokas) from 135 countries participated in judo competitions,⁵ and therefore, judo accounted for 1 of the 3 most popular sports in the London Olympic Games.

Literally, judo is described as “the gentle/flexible way.” Judo splits into kata-oriented judo and competition-oriented judo. In kata, fixed techniques are set in a specific order without resistance or carried out with ukes’ agreement (*uke*: passive part; *tori*: active part).⁶ Competition-oriented judo is about defeating the partner: in this case, the opponent. For this, one may use throwing, holding, strangulation, and armbar techniques, some of which may physically incapacitate the opponent. In competition-oriented judo, the resistance of the partner plays an important biomechanical role, which may lead to injuries.

Data on long-term medical surveillance of judo-related traumatic injuries are lacking in the literature. A study

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by Engebretsen et al⁵ of sports-related injuries at the 2012 London Olympics demonstrated that the 383 participating judokas sustained a total of 47 injuries (12.3%). In 153 female judokas, 19 injuries (12.4%) were documented, whereas in 230 male judokas, 25 (10.9%) injuries were reported. The most common injuries were joint sprains and muscle strains.⁵ This study examined a single competition and collected data solely on elite athletes.

Medical surveillance during competitions may play a role in the prevention and management of sport-related injuries in judo athletes, as it may increase the detection of risk factors and determine the mechanisms of injuries. The aim of our study was to describe the incidence rates and specific types of traumatic injuries that occurred in French judo competitions over a period of 21 years as well as to analyze differences in the incidence rates of specific injuries with respect to athlete sex, age, and level of performance.

METHODS

Study Design

For 21 seasons (1993/1994 to 2013/2014), the medical team of the French Judo Federation (FFJDA) prospectively instituted an injury surveillance system to document injuries through a standardized medical documentation form, which was distributed to all medical teams in charge of the supervision of judo competitions. After each event, completed forms were sent to a member of the medical team at the FFJDA headquarters. The form queried for information about athlete age and sex, as well as the medical diagnosis of an injury including the severity and anatomic region involved after a clinical examination performed at the site of the competition. If the clinical diagnosis could not be established on-site, a member of the medical team contacted the injured athlete during the following week to obtain confirmation of the final diagnosis after an imaging assessment was performed. Only then was the final completed file containing the final diagnosis sent to the medical study team to be included in analyses.

The age and sex of all judokas were recorded. Athletes were categorized as children (10-14 years), adolescents (15-17 years), young adults (18-20 years), adults (21-35 years), and older adults (>35 years). All relevant traumatic

injuries recorded for the purpose of this study were those that resulted in an interruption of practice (either in competition or training) for more than 1 week.

Data on the number of judo participants were collected for each competition separately. Regarding level of performance, athletes at competitions were divided into 2 groups: group N consisted of judo athletes with higher levels of performance participating in national competitions (mainly the French Judo Championships) and international competitions being held in France (including the Grand Slam in Paris and the international junior tournament in Lyon). Judo athletes with lower levels of performance participating in competitions at regional and district levels were included in group R.

Statistical Analysis

Descriptive analysis of injuries and their distribution regarding age, sex, and level of performance was conducted. The incidence proportion rates were calculated for each type of injury in each category considered (age, sex, and level of performance). The incidence rates of injuries took into account the number of participating athletes in each competition separately. Statistical analysis was performed using the XLSTAT 201 software package (Addinsoft). The Student *t* test and chi-square test were used to evaluate the differences in incidence rates of specific injuries regarding sex, age, and level of performance.

RESULTS

From 1993 to 2014, a total of 1839 competitions were medically supervised: 64 international competitions, 239 national competitions, 580 regional competitions, and 956 district competitions. Figure 1 presents the demographic data of the athletes included in this study.

Table 1 shows the total number of injuries reported during the study period. In a total of 421,670 fights that had medical surveillance, 3511 injuries in 316,203 judokas were reported (incidence proportion, 1.1%). Regardless of sex, age, and level of performance, a sprain was the most frequently reported injury type. The most frequently sprained area was the acromioclavicular (AC) joint ($n = 376$; 19.7% of all sprains).

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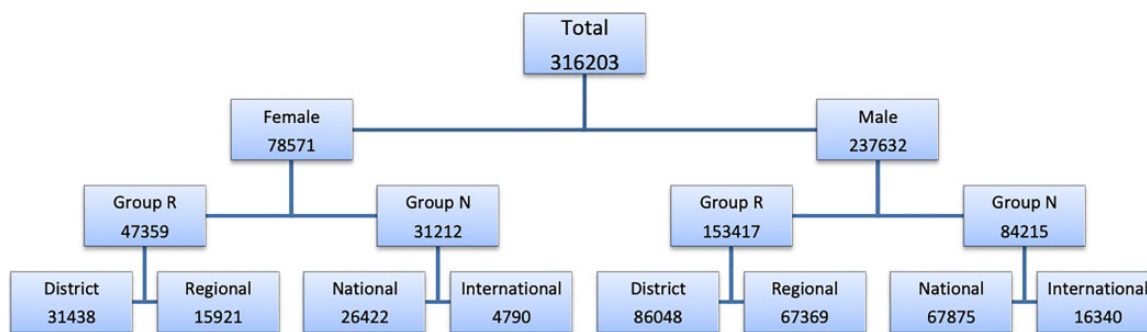


Figure 1. Demographic data of the athletes.

TABLE 1
Injuries Reported During 21 Years of Judo Competitions in France^a

Type of Injury	Total	Upper Limb	Lower Limb	Cervical Spine	Rib	Face
Sprain	1907 (54.3)	878 (46.0)	635 (33.3)	319 (16.7)	75 (3.9) ^b	54 (9.8)
Fracture	548 (15.6)	376 (68.6)	55 (10.0)	4 (0.8)	59 (10.8)	
Dislocation	439 (12.5)	392 (89.3)	47 (10.7)			
Muscle injury	245 (7.0)					
Sutured wound	114 (3.2)					
Head trauma with loss of consciousness	54 (1.5)					
Choking with loss of consciousness	47 (1.3)					
Disabling low back pain	43 (1.2)					
Glenoid labral lesion	31 (0.9)					
Meniscal lesion	15 (0.4)					
Other	68 (1.9)					
Total	3511 (100.0)					

^aData are reported as n (%).

^bChondrocostal sprain.

TABLE 2
Distribution of Participants and Injuries in Each Category^a

Category	Total Participants	Total Injuries	Sprain	Fracture	Dislocation
Sex					
Male	237,632	2466 (1.04)	1262 (0.53)	401 (0.17)	338 (0.14)
Female	78,571	1045 (1.33)	645 (0.82)	147 (0.19)	101 (0.13)
Age group					
Children (10-14 y)	84,321	575 (0.68)	296 (0.35)	153 (0.18)	43 (0.05)
Adolescents (15-17 y)	62,412	727 (1.16)	385 (0.62)	127 (0.20)	62 (0.10)
Young adults (18-20 y)	50,022	781 (1.56)	455 (0.91)	104 (0.20)	115 (0.23)
Adults (21-35 y)	117,811	1410 (1.20)	765 (0.65)	159 (0.13)	218 (0.18)
Older adults (>35 y)	1637	16 (0.98)	6 (0.37)	5 (0.30)	1 (0.06)
Level of performance ^b					
Group R	201,172	1859 (0.92)	958 (0.48)	353 (0.17)	274 (0.14)
Group N	115,031	1652 (1.44)	949 (0.82)	195 (0.17)	165 (0.14)

^aData are reported as n (%).

^bGroup N consisted of judo athletes with a higher level of performance participating in national competitions (mainly the French Judo Championships) and international competitions being held in France (including the Grand Slam in Paris and the international junior tournament in Lyon). Group R consisted of judo athletes with a lower level of performance participating in competitions at regional and district levels.

Table 2 shows the total number of injuries in each group with regard to age, sex, and level of performance as well as the different types of injuries reported in each group and the respective incidence rates. Because of the low frequency

of injuries (0.98%; n = 16), the age group of older adults was not considered in the analyses.

Among the injuries recorded, the most common were sprains (54.3%), fractures (15.6%), and dislocations

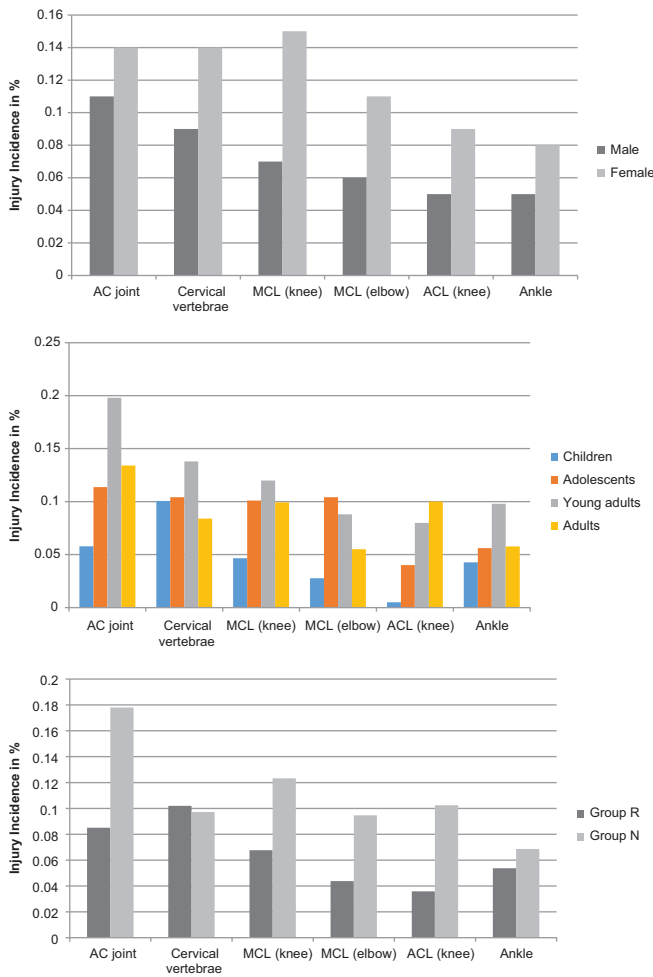


Figure 2. Sprain injuries. AC, acromioclavicular; ACL, anterior cruciate ligament; MCL, medial collateral ligament.

(12.5%). Considering all injuries reported, the incidence rates were higher in female judokas (1.33%), young adult judokas (1.56%), and judokas in group N (1.44%).

Sprains

A total of 1907 sprains were reported, which accounted for 54.3% of all injuries. The 6 most frequently sprained joints accounted for over 75% of total sprain injuries (Figure 2).

The incidence rate for overall sprain injuries was significantly higher for female compared with male athletes (0.82% vs 0.53%, respectively; $P < .001$). Female judokas more often sustained knee sprains (0.24%) compared with male judokas (0.12%) ($P < .001$). Knee sprains corresponded to anterior cruciate ligament (ACL) sprains (female: 0.09%, male: 0.05%; $P < .001$) and medial collateral ligament (MCL) sprains (female: 0.15%, male: 0.07%; $P < .001$).

Regarding level of performance, athletes from group N had almost twice the incidence rate of overall sprains compared with group R (0.82% vs 0.48%, respectively; $P < .001$). There were significant between-group differences in the incidence of sprains to the AC joint (group R: 0.09%, group

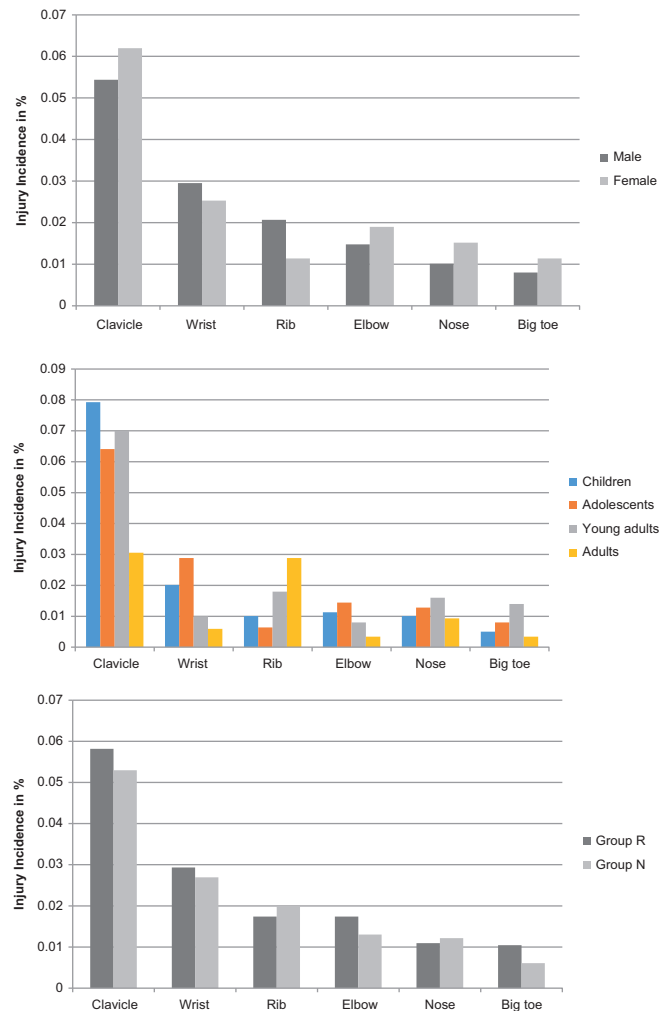


Figure 3. Fracture injuries.

N: 0.18%), MCL sprains of the knee (group R: 0.07%, group N: 0.12%), MCL sprains of the elbow (group R: 0.04%, group N: 0.09%), and ACL sprains (group R: 0.04%, group N: 0.10%) ($P < .001$ for all).

Regarding age, young adult judokas had a higher incidence rate for AC sprains compared with the other age groups (adults: 0.13%, young adults: 0.20%, adolescents: 0.11%, children: 0.06%; $P < .001$).

Fractures

A total of 548 fractures were reported: 376 affected the upper extremities/upper body, with the clavicle being the most frequently fractured location. Figure 3 shows the 6 most frequent fractures reported with regard to age, sex, and level of performance.

Four cases of severe cervical fractures associated with tetraplegia were documented in male judokas (group R: n = 3, group N: n = 1). Regarding the incidence rates of fractures, there were no significant differences when stratified by sex or level of performance. Regarding the different age groups, children aged 10-14 years had a significantly

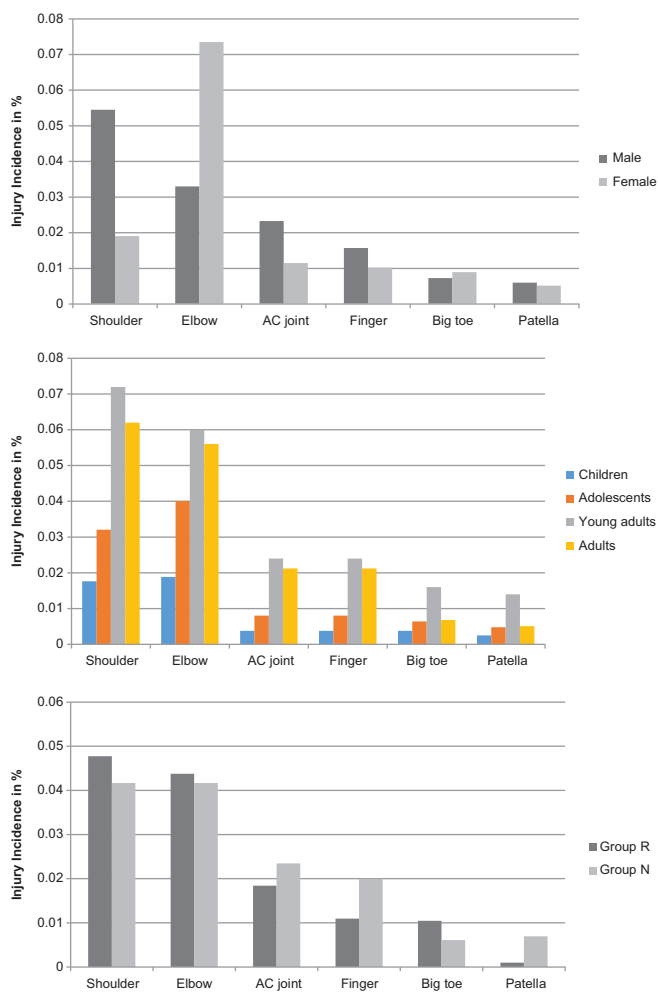


Figure 4. Dislocation injuries. AC, acromioclavicular.

higher incidence rate of clavicle fractures when compared with adults aged 21-35 years (0.08% vs 0.03%, respectively; $P < .001$).

Dislocations

The shoulder and elbow were the most commonly affected joints dislocated (Figure 4). The incidence rate of shoulder dislocations was higher in male athletes than female athletes (0.05% vs 0.02%, respectively; $P < .001$). The incidence rate of elbow dislocations was higher among female athletes than male athletes (0.07% vs 0.03%, respectively; $P < .001$). Regarding the age groups, young adults (18-20 years) and adults (21-35 years) had higher incidence rates of shoulder dislocations compared with the other groups (children: 0.02%, adolescents: 0.03%, young adults: 0.07%, adults: 0.06%; $P < .001$).

Other Injuries

A total of 54 cases of head trauma with loss of consciousness and 47 cases of choking with loss of consciousness

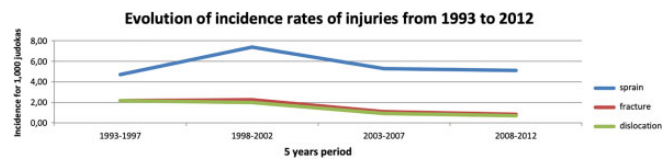


Figure 5. Injury incidence rates, calculated as injuries per 1000 judokas.

were reported. No cases of death or permanent brain damage were reported after these injuries. There were no significant differences in the incidence rates of these injuries when compared by age, sex, or level of performance.

Overall, 245 muscle injuries were reported. Regarding the mechanism of injury, 132 were direct and 113 were indirect. There were no significant differences in incidence rates of muscle injuries between the groups regarding age, sex, or level of performance.

Evolution of Incidence Rates of Injuries Over the Study Period

Over the 21-year period of medical surveillance, the incidence rates of fractures and dislocations decreased for all groups (age, sex, and level of performance), mainly after the period of 1998-2002 (Figure 5). The incidence rate of sprains increased from the 1993-1997 period to the 1998-2002 period, after which we documented a substantial decrease (Figure 5).

DISCUSSION

In this large descriptive epidemiological study including 21 seasons of judo competitions in France, the overall incidence rate of traumatic injuries reported was 1.1%. Sprains were the most frequent injuries reported, followed by fractures and dislocations. Regarding overall injuries reported, the incidence rates of injuries were higher among female athletes, young adult athletes (aged 18-20 years), and athletes exhibiting higher levels of performance (group N).

Sprains

Sprains were the most frequent injury type in our study, particularly those to the knee, with higher incidence rates reported for female judokas sustaining an MCL or ACL injury. These results are consistent with the findings of Akoto et al.² The proportion of MCL sprains is also consistent with a previous report from Gal et al.⁷ regarding judo-related injuries in the Netherlands. Higher rates of knee sprains in female versus male athletes have also been documented in other sports.^{3,30,33,39}

A reason why female athletes suffered significantly more sprain injuries (mainly MCL and ACL injuries in the knee) than male athletes could be related to a higher amount of estrogen during the menstrual cycle, which may lead to an increased risk for such injuries. Studies in female soccer

athletes showed a relationship between the menstrual cycle and increased injury rates.^{10,20,21} Furthermore, Liu et al¹⁸ showed that an increased concentration of estrogen in ACL tissue culture models resulted in a decreased amount of fibroblast and procollagen production, which supports the hypothesis that estrogen levels might be related to higher rates of sprains in female athletes. However, we did not collect specific data on the menstrual cycle during our surveillance. Other factors that may have contributed to such a difference in the rates of knee sprains between female and male judokas include greater knee joint laxity and further diminished joint proprioception observed in women³² as well as anatomic differences between the sexes, such as a narrower femoral notch or an increased Q-angle in women.⁹

Studies in judo and other sports have also demonstrated higher rates for sprain injuries with higher performance levels.^{1,2,14,16} In fact, such athletes (as the ones in group N in the current study) devote more time to training and competitions. This increases their power and speed, resulting in stronger impacts during full-body contact. Furthermore, the increased exposure to full-body contact elevates the risk of injuries.

The high number of AC sprains (n = 376; incidence rate, 0.12%) in our study, especially among group N, can be explained by direct falls on the shoulder or the use of the arm as stabilization in abduction to avoid getting thrown. Interestingly, young adult athletes (aged 18-20 years) had the highest incidence rate of AC sprains of all age groups. This could be explained by the fact that most young adult athletes start searching for more engagement and contact while not yet having optimal control of the different techniques of fighting, which is not the case for younger (less engagement and contact) and older (more control of techniques) groups.

Fractures

The most frequently fractured area reported was the clavicle. Two mechanisms are related to clavicle fractures in judo: direct trauma on the collarbone or indirect trauma with a fall on the shoulder, producing a transmission of force onto the clavicle and causing it to fracture. In wrestling, which has some movement patterns in common with judo, clavicle fractures are also frequent.^{11,26} When comparing the incidence rates with respect to sex and level of performance, no significant differences were found in our study. However, we found that children aged 10-14 years had significantly more clavicle fractures than adults aged 21-35 years. This could be explained by the fact that younger athletes have less control of techniques while engaging in combat than older athletes. Another reason could be that younger athletes have less experience in being thrown and performing proper *ukemi* (falling on the mat) compared with their older counterparts. Furthermore, the fact that there is less muscle mass or strength in children to absorb the impact may have contributed to such a finding.

We documented 4 cases of cervical fractures associated with tetraplegia over 21 years of competitions, with most of these cases affecting judo athletes with lower levels of performance (group R). Kamitani et al¹³ reported 14

traumatic cervical spine injuries with tetraplegia in 7 years of monitoring Japanese judo. One reason to explain the difference in injury rates is that the athletes in the highest performance group have a more developed muscle system in the neck region, which may prevent severe spine trauma when falling on the neck. Another reason could be that the techniques used at higher levels are executed with greater precision.

Dislocations

In various sports, a shoulder dislocation is a frequent injury.^{8,11,19,25,36} Our study showed that male judokas exhibited a higher incidence rate of shoulder dislocations compared with female athletes. Previous studies in judo did not report significant differences between female and male athletes regarding shoulder dislocations.² The higher number of shoulder dislocations in male athletes could be explained by the different fighting style of male judokas. Female judokas typically fight with a sleeve and lapel grip to obtain better control of the opponent (potentially decreasing the risk of shoulder dislocations), whereas male judokas fight in a more aggressive way with more full-body contact and more infighting techniques, which often results in a higher risk of getting thrown (potentially increasing the risk for shoulder dislocations).

In our study, the incidence rate of elbow dislocations was significantly higher in female judokas. Two main scenarios may lead to such an injury. In the first one, the defender leans with a bent arm on the mat.¹⁷ In the second one, the defender is suffering an armbar.^{34,35} In both scenarios, the forces acting toward the elbow joint are intense. Previous studies have shown that joint laxity in women is higher than in men.^{15,37,38} This could be one of the reasons explaining the higher incidence rate of elbow dislocations among female athletes.

Regarding the higher incidence rate of shoulder dislocations in young adults and adults, an explanation could be that children and adolescents are only allowed to fight without using full-contact techniques.

Concussions

In judo, 2 mechanisms may lead to loss of consciousness: head trauma with a concussion caused by hitting the mat or being choked by an opponent and being unwilling or unable to tap out (to give up). The International Judo Federation rules state that if a judoka is unconscious after strangulation, the fight is immediately over. However, the athlete is allowed to continue the competition in *repechage* (judo athletes who have lost a combat against an opponent who could make it to the semifinals may return later to fight for third place overall). Radafy et al²⁸ showed that 82% of the fighters who were unconscious after strangulation returned to judo after a few minutes. In 2 studies, brain activity assessed by electroencephalography returned to normal levels 3 minutes after being choked.^{29,31} There are no studies about the long-term effects of choking for athletes in judo.

The occurrence of concussions in judo has been mentioned many times in the literature,^{2,4,23,24,27,28} but there

is as yet no specific return-to-judo guideline after a concussion to help with the decision of how and when a judoka is ready to get back on the mat.

Evolution of Incidence Rates of Injuries Over the Study Period

Starting in 2000, the International Judo Federation sanctioned techniques that used the head as ground support when throwing the opponent to reduce the occurrence of severe injuries. This could be one of the reasons why the incidence of fractures has been decreasing in the past 15 years (Figure 5). In 2017, Kamitani et al¹² published a study focusing on the prevention of severe head and neck injuries to help reduce this type of injury. In the current study, we believe that such rule changes had a positive impact in preventing such injuries, as the overall mean incidence rate for cervical injuries decreased from around 1.4 injuries per 1000 athletes in 1993-2002 to around 0.6 injuries per 1000 athletes in 2003-2013. We did not document any severe cervical or head trauma after the implementation of this rule. Furthermore, it is possible that the introduction of such rules played a role in decreasing the incidence rates of less severe injuries after the 1998-2002 period, including fractures, sprains, and dislocations.

Limitations

The majority of the injury diagnoses were determined by a clinical examination only, carried out by the physician in charge of the competition. If imaging assessments were available for all injuries occurring in judo athletes, we would certainly have more accurate diagnoses reported. We acknowledge that the clinical experience of physicians participating in this surveillance was unequal in some cases, so it could be possible that the results of the examinations performed could have depended on the examiner. We did not collect data on the specific mechanism of injuries during the study period. To better understand the mechanisms leading to a specific injury and to improve the prevention of injuries during competitions, the FFJDA set up a video analysis system implemented at every national competition since 2015 (after our study was conducted), which is being supervised by a group of medical and technical experts. Although the same athlete could exhibit more than 1 injury for the same competition (as we considered only injuries resulting in an interruption of practice for more than 1 week), we cannot rule out the possibility that the same participant could have developed another incident injury in another competition during the same year, which may have affected the incidence rates reported.

Furthermore, only medical interventions for relevant traumatic injuries on-site were documented, corresponding to injuries resulting in an interruption of practice for more than 1 week, so the total number of injuries could be higher than the ones reported in our study. Finally, we did not collect data on the weight of judokas, and we know that the fighting style of judo may be different among categories defined by body weight.

CONCLUSION

In this large epidemiological study including 21 years of medical surveillance of injuries in judo competitions in France, there was a low incidence of judo-related injuries, reported to be only 1.1%. Some specific injuries were more frequent depending on the athlete's age, sex, and level of performance. The knowledge of such differences may help in developing strategies to prevent injuries in future judo competitions.

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