

ORIGINAL ARTICLE

Effects of the new karate rules on the incidence and distribution of injuries

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Objectives: To evaluate the incidence and distribution of injuries in karate before and after the implementation of new rules established by the World Karate Federation in 2000.**Methods:** Injury incidence was followed up during the official karate competition seasons of 1997 and 2002 in Croatia. A questionnaire was used to collect data on the age and sex of the competitor and localisation and severity of injury. Data were analysed separately for female and male competitors and age categories <18 and ≥18 years.**Results:** A total of 2023.5 and 2584 minutes of active fighting (exposure time) was assessed for 1997 and 2002 respectively. The overall injury incidence rate (IR) was similar in 1997 and 2002 (10.28 and 9.82/100 exposure minutes respectively). The relative risk (RR) of injury was significantly higher in 1997 than in 2002 for competitors younger than 18 years (RR 1.55, 95% confidence interval (CI) 1.11 to 2.16). The overall RR of head injury was significantly higher in 1997 than in 2002 (RR 1.96, 95% CI 1.54 to 2.49), but the RR of leg injury was significantly lower in 1997 than in 2002 (RR 0.16, 95% CI 0.09 to 0.28). Most injuries (>98%) were categorised as mild (grade 1) in both periods studied.**Conclusions:** The results of this study confirm the importance of the new competition rules in the distribution and prevention of injuries in martial arts. Strict judging and heavy penalties for uncontrolled blows, particularly for the youngest competitors, can significantly decrease the risk of injury.

Over the last 15 years, modern non-contact karate has become a very popular competitive and recreational sport involving a great number of children and adolescents in many European countries including Croatia. The Croatian Karate Union consists of about 130 karate clubs.¹ It has been a member of the European Karate Federation (EKF) and the World Karate Federation (WKF) since 1992, and most karate competitions in Croatia are carried out according to the WKF rules. Modern non-contact karate tournament competitions consist of two disciplines: kata and kumite. Kata means fights with imaginary opponents, and kumite is a synonym for karate fight.² In a non-contact karate fight, punches and kicks must be controlled (without injury to the opponent) or stopped before contact with the opponent's body. Correctly executed techniques to the head or trunk are scored. For uncontrolled punches and kicks, the competitor receives a penalty and the opponent wins a point.³

Sports injuries are considered to be one of the most common form of injury in modern western societies, and karate is often cited among the sports with high risk of injury.^{4–6} Treatment of sports injuries is medically complex, time consuming, and expensive. Therefore the implementation and evaluation of new injury preventive measures and strategies is of great scientific, medical, and financial importance.⁷

In the year 2000, WKF changed the rules of karate competition in an effort to promote the sport of karate, decrease injury rates, and make competitions more dynamic and attractive.⁸ For kumite, the greatest changes were in the scoring. Kicks to the head and throwing followed by a scoring move are awarded 3 points ("sanbon"), kicks to the trunk and punches to the back, including the back of the head and neck, are awarded 2 points ("nihon"), and punches to the head and trunk are awarded 1 point ("ippon"). For comparison, old rules included two possible scores: 1 point ("ippon") for kicks to the head, throwing followed by a

scoring move, and punches to the back, including the back of the head and neck; 0.5 point ("wazari") for punches to the head and trunk, and kicks to the trunk. To achieve injury prevention, new rules are stricter about prohibited behaviour for competitors, including excessive force used in dealing blows to permitted areas, to the forbidden areas (throat, arms, legs, joints, and instep), blows to the face with open hand techniques, and dangerous or prohibited throwing techniques. Any illegal behaviour results in a warning or penalty. For senior and junior competitors (≥18 years of age), non-injurious, light, and controlled contact with the face, head, and neck is allowed (but not to the throat). For cadets (16–17 years of age), all hand techniques to the head, face, and neck must have absolute control. If the glove touches the targeted area, the referees will not award a score. Only a light touch is allowed for kicking techniques to the head, face, and neck. As far as compulsory protective equipment (gloves and gum shields) is concerned, the size and shape of protective gloves have been standardised since 2000.

In this study we wanted to see whether the implementation of the new rules had influenced the incidence, distribution, and severity of competition related injuries. We therefore analysed the records on injury rates, distribution, and severity obtained during official karate (kumite) competitions in Croatia before and after the implementation of the new WKF rules in 2000.

METHODS

This study was designed as a prospective open cohort study with a follow up of injury incidence during the kumite competition seasons of 1997 and 2002. Competitions for both sexes and all age groups were carried out according to the WKF rules valid at the time of the study. The competitors

Abbreviations: IR, incidence rate; IRR, incidence rate ratio; RR, relative risk

Table 1 Age categories of competitors and the respective duration of active fighting

Age category	Age (years)	Duration (min)	
		Male	Female
Pupils	12, 13	1	1
Younger cadets	14, 15	1.5	1.5
Cadets	16, 17	2	2
Juniors	18, 19, 20	2	2
Seniors	≥18	3	2

were required to wear protective gloves and gum shields as obligatory protective equipment in both periods studied. In 2002, protective gloves had to be standardised according to the new kumite rules.⁸ Table 1 shows age categories and duration of active fighting according to age category. The 1997 data were collected during the official championship of the Zagreb region and the national championships for all age categories. The 2002 data were also collected during the official championship of the Zagreb region for all age categories, during the national championships for pupils and younger cadets, and during an official international tournament, the Croatia Cup, for all age categories. The Croatia Cup has been held every year since 1994 and has the rank of an open Croatian championship.

A simple questionnaire was used to collect data on injuries. The information included the age and sex of the competitor and the localisation and severity of the injury. Injuries recorded were those that required medical attention during the competition, based on the opinion of the competitor or the referee. Data were collected by doctors (authors of this study), who were officially attending the competitions and are qualified and experienced enough to evaluate and treat karate related injuries. The competitors who were followed up in this study are anonymous, and there is no chance that any can be identified from the study. Questionnaire data did not include the names of the competitors.

Data were analysed separately for female and male competitors and for two age categories: <18 years (including pupils, younger cadets, and cadets) and ≥18 years (including juniors and seniors). Age groups correspond to those in the kumite rules, which are stricter for younger competitors (<18 years) than for juniors and seniors (≥18 years).⁸

Injuries were divided into three grades with regard to severity:

- grade 1: competitor was injured but was able to continue the competition;
- grade 2: injuries that required withdrawal from the competition and special medical examination and treatment;
- grade 3: injuries that required hospital admission.

Injuries were also analysed by head, neck, trunk (including genital area), arms, and legs.

Statistical analysis was performed using Stata/SE 9.0 for Windows (StataCorp LP, College Station, Texas, USA) and included descriptive methods and epidemiological analysis (incidence rate (IR) and incidence rate ratio (IRR)). $p \leq 0.05$ was considered significant.

IR was calculated according to exposure time in minutes (exposure time = number of fights × duration of active fight in minutes). Exposure time is cumulative active fighting time for each age and sex group included in the study.

RESULTS

This study covered 887 karate matches in 1997 and 1604 in 2002 (table 2).

In 1997, the overall injury incidence rate was 10.28/100 exposure minutes (95% confidence interval (CI) 8.93 to 11.77), with the highest incidence rates recorded for female competitors <18 years (22.5/100 exposure minutes, 95% CI 13.33 to 35.56). In 2002, the overall injury incidence rate was 9.82/100 exposure minutes (95% CI 8.66 to 11.12), with the highest incidence rates recorded for women ≥18 years (15.53/100 exposure minutes, 95% CI 10.63 to 21.93). In both periods, men ≥18 years showed the lowest injury incidence rate (IR 9.23 per 100 exposure minutes, 95% CI 7.64 to 11.06, and IR 7.23 per 100 exposure minutes, 95% CI 5.42 to 9.46 respectively) (table 3).

Table 4 shows that the relative risk (RR) of injury was significantly higher in 1997 than in 2002 for female competitors younger than 18 years (RR 2.08, 95% CI 1.24 to 3.49, $p = 0.0108$) and for both sexes in the <18 year age group (RR 1.55, 95% CI 1.11 to 2.16, $p = 0.0137$). In the male competitors (<18 and ≥18 years), the RR of injury was higher in 1997 than in 2002, but the difference was not significant (RR 1.31 and 1.28 respectively). For women aged 18 and above, the RR of injury was lower in 1997 than in 2002 with a borderline level of significance (RR 0.636, 95% CI 0.407 to 0.992, $p = 0.0521$).

The overall RR of head injury was significantly higher in 1997 than in 2002 (RR 1.96, 95% CI 1.54 to 2.49, $p < 0.0001$), but the overall RR of trunk and leg injury was significantly lower in 1997 than in 2002 (RR 0.39, 95% CI 0.21 to 0.73, $p = 0.0028$, and RR 0.16, 95% CI 0.09 to 0.28, $p < 0.0001$ respectively) (table 5). The difference in leg injury incidence rates between the two periods studied was significant in all the age and sex groups, except boys younger than 18 years.

For head injuries, the difference in incidence rates between the two periods was significant in all age and sex groups, except for the women 18 years and older. The data on site of injuries collected in 1997 have already been reported in a preliminary publication⁹ as a proportion of total number of injuries by age and sex.

Most injuries were categorised as grade 1 severity in both periods studied and included contusions, lacerations, excoriations, strains, sprains, nose bleeding, and blisters (table 6). In 1997, five out of 208 injuries were categorised as grade 2 (fracture of the nasal bone, dislocation of the 3rd metatarsophalangeal joint, carpal joint, and elbow, and fracture of the 4th metacarpal bone). No grade 3 injuries were observed in 1997. In 2002, two out of 254 injuries were categorised as grade 2 (fracture of the nasal bone and "knock-down" with amnesia and confusion without loss of consciousness), and one as grade 3. The latter was a fracture of the facial bone

Table 2 Number of matches (N) and exposure time (ET) in minutes according to the age (≥18 and <18 years) and sex of competitors in 1997 and 2002

	≥18 years		<18 years		Total	
	N	ET (min)	N	ET (min)	N	ET (min)
1997						
Female	238	476	49	79.5	287	555.5
Male	463	1278	137	190	600	1468
Total	701	1754	186	269.5	887	2023.5
2002						
Female	103	206	395	546	498	752
Male	255	733	851	1099	1106	1832
Total	358	939	1246	1645	1604	2584

Table 3 Number of recorded injuries and injury incidence rate per 100 minutes of exposure time, by competitors' age (≥ 18 and < 18 years) and sex in 1997 and 2002

	≥ 18 years		< 18 years		Total	
	N	IR/100 min	N	IR/100 min	N	IR/100 min
1997						
Female	47	9.87 (7.26 to 13.13)	18	22.5 (13.33 to 35.56)	65	11.7 (9.02 to 14.90)
Male	118	9.23 (7.64 to 11.06)	25	13.16 (8.51 to 19.42)	143	9.74 (8.21 to 11.47)
Total	165	9.41 (8.03 to 10.96)	43	15.93 (11.53 to 21.45)	208	10.28 (8.93 to 11.77)
2002						
Female	32	15.53 (10.63 to 21.93)	59	10.81 (8.23 to 13.94)	91	12.1 (9.74 to 14.86)
Male	53	7.23 (5.42 to 9.46)	110	10.01 (8.23 to 12.06)	163	8.89 (7.58 to 10.37)
Total	85	9.05 (7.23 to 11.19)	169	10.27 (8.78 to 11.94)	254	9.82 (8.66 to 11.12)

Values in parentheses are 95% confidence intervals.

N, Number of recorded injuries; IR, injury incidence rate: $IR = (N/\text{exposure time in minutes}) \times 100$.

(ossis zygomatici) with lesion of the nervus trigeminus. All injuries categorised as grades 2 and 3 in both periods were in men competitors (cadets, juniors, and seniors).

DISCUSSION

In this study we were able to establish and evaluate differences in the incidence and localisation of injuries sustained in karate fights between two periods in which different competition rules prevailed.

There is a clear evidence that the new rules implemented in 2000 greatly affected the distribution of injuries, reducing the incidence of head injuries and increasing the incidence of leg injuries in all age and sex groups studied. Although head injuries had the highest incidence in both periods, their rate fell from 8.05/100 exposure minutes in 1997 to 4.1/100 exposure minutes in 2002. This change is in contrast with an increased incidence of leg injuries (0.54/100 exposure minutes in 1997 to 3.33/100 exposure minutes in 2002). According to the new scoring rules,⁸ leg techniques are awarded 2 or 3 points, and hand techniques 1 or 2 points, which makes leg techniques more popular among competitors than previously. Frequent use of kicks during a fight results in more leg injuries. Leg injuries mostly occur during contact of the instep or shin with the opponent's elbow, hip, or forearm. The leg is also often injured when both opponents perform a leg manoeuvre at the same time. During the European and World karate championships in 2005, instep protection equipment was promoted as a measure of instep and head injury prevention, and its future use will establish its efficacy. The decreased incidence of head injuries can partly be explained by the influence of the new scoring rules in changing fight strategies, but there is also the obligatory use of standardised protective gloves from 2000. Gloves were previously different in shape, thickness, and hardness and did not provide the same protection from injury.¹⁰

The overall injury incidence rate in 1997 and 2002 was similar (10.28 and 9.82 per 100 exposure minutes respectively) and was comparable to the results of other studies using similar methods. Stričević and colleagues,¹¹ McLatchie,¹² Tuominen¹³ and Johannsen and Noerregaard¹⁰

recorded about one injury per four karate fights (0.27, 0.27, 0.28, and 0.26 injuries per fight respectively). Critchley and colleagues¹⁴ found a rate of 0.09 injuries per fight in shotokan karate competitions. If we express our results as incidence rate per fight as most authors have, the overall injury incidence rate can be estimated at 0.23/fight in 1997 (208 injuries/887 fights) and 0.16/fight in 2002 (254 injuries/1604 fights), or one injury in five fights in 1997 and one injury in six fights in 2002.

Although there was no significant change in the overall injury incidence in the two periods studied, our results show a decrease in injury incidence in the younger age categories (under 18 years) after the implementation of the new rules, particularly in female competitors. The relative risk of injury before the implementation of the new rules was significantly higher than after their implementation. The new stricter rules for younger categories of competitors (pupils, younger cadets, and cadets) were meticulously implemented by the Croatian referees, and this seems to have had a significant impact on injury prevention, especially in view of head injuries, which are often more severe than other injuries.

Female competitors showed the highest injury incidence rates in this study, for which we do not have a satisfactory explanation. These findings, however, may be related to a generally lower level of technical and tactical skills and less competition experience in female than male competitors in Croatia, particularly in 1997. The number of fights for girls in 1997 was only 49. This suggests that karate was not a very popular sport among girls. Since 1997, its popularity has grown among girls and women in Croatia, and the greater number of competitors has led in turn to greater technical and tactical skills. The significant decrease in injury incidence rates in 2002 in young girls is encouraging indeed. We can also speculate that the other reason for the higher injury incidence in female competitors is the behavioural difference, which is sex specific. Namely, men more often overlook or cover up an injury than women.

Most of the injuries sustained (203 of 208 injuries in 1997, and 251 of 254 injuries in 2002) were categorised as grade 1, with the injured competitors able to continue the

Table 4 Injury incidence rate ratios between the two periods studied (1997/2002) by competitors' age (≥ 18 and < 18 years) and sex

	≥ 18 years		< 18 years		Total	
	IRR	p Value	IRR	p Value	IRR	p Value
Female	0.636 (0.407 to 0.992)	0.0521	2.08 (1.24 to 3.49)	0.0108	0.966 (0.703 to 1.33)	0.8354
Male	1.28 (0.924 to 1.764)	0.1369	1.31 (0.853 to 2.03)	0.2233	1.09 (0.875 to 1.37)	0.4293
Total	1.04 (0.799 to 1.35)	0.7786	1.55 (1.11 to 2.16)	0.0137	1.05 (0.870 to 1.26)	0.6338

Values in parentheses are 95% confidence intervals.

IRR, Injury incidence rate ratio.

Table 5 Injury incidence rates per 100 minutes of exposure time and incidence rate ratios between 1997 and 2002, by the site of injury and competitors' age (≥ 18 and < 18 years) and sex

Site of injury	IR/100 min		1997/2002	
	1997	2002	IRR	p Value
Female ≥ 18 years				
Head	7.56	6.79	1.11 (0.60 to 2.06)	0.7509
Neck	1.05	0	–	–
Trunk	0.63	1.94	0.32 (0.08 to 1.34)	0.1584
Arms	0.42	1.46	0.29 (0.05 to 1.55)	0.1974
Legs	0.21	5.34	0.04 (0.01 to 0.15)	<0.0001
Female < 18 years				
Head	18.75	4.03	4.65 (2.56 to 8.44)	<0.0001
Neck	1.25	0.37	3.41 (0.36 to 32.58)	0.3813
Trunk	2.5	2.02	1.24 (0.28 to 5.58)	0.7348
Arms	0	0.73	–	–
Legs	0	3.66	–	–
Female, total				
Head	9.17	4.79	1.92 (1.26 to 2.91)	0.0027
Neck	1.08	0.27	4.06 (0.93 to 17.76)	0.0798
Trunk	0.9	1.99	0.45 (0.17 to 1.21)	0.1165
Arms	0.36	0.93	0.39 (0.09 to 1.76)	0.2401
Legs	0.18	4.12	0.04 (0.01 to 0.17)	<0.0001
Male ≥ 18 years				
Head	7.43	3.41	2.18 (1.42 to 3.35)	0.0002
Neck	0.39	0.27	1.43 (0.28 to 7.33)	0.7091
Trunk	0.31	0.82	0.38 (0.11 to 1.29)	0.1458
Arms	0.55	0.14	4.01 (0.58 to 27.82)	0.1753
Legs	0.55	2.59	0.21 (0.10 to 0.46)	0.0002
Male < 18 years				
Head	8.95	4.09	2.19 (1.27 to 3.76)	0.01
Neck	0.53	0.18	2.89 (0.29 to 28.60)	0.439
Trunk	1.58	1.64	0.96 (0.28 to 3.27)	1.0077
Arms	0.53	0.82	0.64 (0.08 to 4.99)	0.7569
Legs	1.58	3.28	0.48 (0.15 to 1.53)	0.213
Male, total				
Head	7.63	3.82	1.99 (1.49 to 2.68)	<0.0001
Neck	0.41	0.22	1.87 (0.54 to 6.50)	0.3468
Trunk	0.48	1.31	0.36 (0.16 to 0.82)	0.013
Arms	0.54	0.55	0.99 (0.39 to 2.53)	1.0039
Legs	0.68	3	0.23 (0.12 to 0.42)	<0.0001
Total female+male				
Head	8.05	4.1	1.96 (1.54 to 2.49)	<0.0001
Neck	0.59	0.23	2.55 (0.99 to 6.57)	0.0588
Trunk	0.9	1.51	0.39 (0.21 to 0.73)	0.0028
Arms	0.4	0.66	0.75 (0.34 to 1.63)	0.4821
Legs	0.54	3.33	0.16 (0.09 to 0.28)	<0.0001

Values in parentheses are 95% confidence intervals.
 IR, injury incidence rate: IR = (number of recorded injuries/exposure time in minutes) \times 100; IRR, injury incidence

competition. Severe injuries happened occasionally, only in male athletes, with similar incidence in the two periods studied. These results are similar to those of other studies.^{13 14} Cerebral concussion was not recorded and can be considered a very rare event in karate fights under modern rules.¹⁵

Intervention studies in the field of sports injury prevention have been rare so far, and their importance in different sports has only relatively recently been emphasised.⁷ Most studies

on injury incidence in karate that we could find are descriptive. However, McLatchie and colleagues¹⁶ studied the effect of protective equipment on injury rates in karate, summarising the data collected over a 10 year period (1974–1983). They found a decrease in injury rate from 0.25 per fight in 1974–1976 to 0.05 per fight in 1980–1983. A more recent study by Burke and colleagues¹⁷ evaluated the implementation of safety measures in taekwon do competi-

Table 6 Number of recorded injuries (N) and injury incidence rate (IR) per 100 minutes of exposure time by injury severity and competitors' sex in 1997 and 2002

Severity	Female		Male		Total	
	N	IR/100 min	N	IR/100 min	N	IR/100 min
1997						
Grade 1	65	11.69 (9.02 to 14.90)	138	9.40 (7.90 to 11.11)	203	10.03 (8.70 to 11.51)
Grade 2	0	0	5	0.34 (0.11 to 0.79)	5	0.25 (0.08 to 0.58)
Grade 3	0	0	0	0	0	0
2002						
Grade 1	91	12.10 (9.74 to 14.86)	160	8.73 (7.43 to 10.20)	251	9.71 (8.55 to 10.99)
Grade 2	0	0	2	0.11 (0.01 to 0.39)	2	0.07 (0.009 to 0.28)
Grade 3	0	0	1	0.05 (0.001 to 0.30)	1	0.04 (0.001 to 0.22)

Values in parentheses are 95% confidence intervals.

What is already known on this topic

- Injury incidence rates in non-contact karate have been reported in several descriptive studies, with most showing rates of about 0.25/fight
- The most common site of injury is the head, but severe injuries are rare

tion. In spite of some methodological weaknesses of this study, the authors found a significant decrease in injury incidence after the implementation of new safety standards including protective equipment, light contact rules of engagement, and mandatory medical supervision.

In conclusion, our results confirm the important role of rules and their strict implementation in the distribution and prevention of injuries in martial arts. Strict judging and heavy penalties for uncontrolled blows, particularly in the youngest athletes, can significantly decrease the risk of injury. Further studies of injury prevention in martial arts should include adequate technical and tactical training, obligatory and recommended protective equipment (standard gloves, gum shields, pads), and attention to the athlete's general condition, including adequate periods of training and rest and proper diet.¹⁸

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What this study adds

- Injuries in non-contact karate before and after the implementation of new rules were evaluated in a prospective cohort study
- Implementation of the new rules significantly lowered the relative risk of injury for competitors <18 years; a significant overall decrease in head injuries and increase in leg injuries was also established

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COMMENTARY

Non-contact karate as a spectator sport suffers compared with full contact sports, as it is harder for the casual observer to identify the most common scoring techniques of punches to the trunk and head. Changes in rules to encourage technical ability, to make competitions more attractive, as well as to improve safety were introduced. The authors have importantly analysed the effects of these introductions. An overall reduction in head injuries and a reduction in all injuries in the under 18 years age group are reported. The importance of strict refereeing as highlighted by the authors again cannot be overemphasised.

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