

Analysis of combat sports players' injuries according to playing style for sports physiotherapy research

Ji-WOONG NOH, PT, MS^{1)a}, BYOUNG-SUN PARK, PT, MS^{1)a}, MEE-YOUNG KIM, PT, PhD¹⁾, LIM-KYU LEE, PT, MS^{1, 2)}, SEUNG-MIN YANG, PT, MS¹⁾, WON-DEOK LEE, PT, MS¹⁾, YONG-SUB SHIN, PT, MS¹⁾, JU-HYUN KIM, PT, PhD³⁾, JEONG-UK LEE, PT, PhD⁴⁾, TAEK-YONG KWAK, PhD⁵⁾, TAE-HYUN LEE, PhD⁶⁾, JU-YOUNG KIM, PhD⁶⁾, JAEHONG PARK, PhD⁷⁾, JUNGHWAN KIM, PT, PhD^{8)*}

¹⁾ Laboratory of Health Science and Nanophysiotherapy, Department of Physical Therapy, Graduate School, Yongin University, Republic of Korea

²⁾ Commercializations Promotion Agency for R&D Outcomes, Republic of Korea

³⁾ Department of Physical Therapy, College of Health Welfare, Wonkwang Health Science University, Republic of Korea

⁴⁾ Department of Physical Therapy, College of Health Science, Honam University, Republic of Korea

⁵⁾ Department of Taekwondo Instructor Education, College of Martial Arts, Yongin University, Republic of Korea

⁶⁾ Department of Combative Martial Arts Training, College of Martial Arts, Yongin University, Republic of Korea

⁷⁾ Department of Social Welfare, College of Public Health and Welfare, Yongin University, Republic of Korea

⁸⁾ Department of Physical Therapy, College of Public Health and Welfare, Yongin University: 470 Samga-dong, Cheoin-gu, Yongin-si, Gyeonggi-do 449-714, Republic of Korea

Abstract. [Purpose] This study describes the characteristics of injuries in strike and non-strike combat sports, and the results are intended for use in the area of sports physiotherapy research. [Subjects and Methods] The study was conducted on 159 athletes involved in a variety of combat sports. The participants included elite college players of the following sports: judo (47), ssireum (19), wrestling (13), kendo (30), boxing (16), and taekwondo (34). Of the participants, 133 were male and 26 were female. In the case of ssireum and boxing, all of the athletes were male. [Results] In the case of the combat sports, the types of injury and injured regions differed according to playing style. Dislocation and injuries to the neck, shoulders, and elbows were more frequent in the non-strike sports, while injuries to the wrists and hands were more frequent in the strike sports. There was a high incidence of sprains, strains, bruises, and injuries to the lower limbs in both groups. [Conclusion] We suggest that the characteristics of injuries in combat sports differ according to playing style, and our study will therefore provide physical therapists and researchers with information that can be used to prevent injury.

Key words: Combat sports, Injury, Sports physiotherapy research

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INTRODUCTION

Combat sports are popular enough to account for 25% of all Olympic medals¹⁾. The term “combat sports” describes a group of sports whose competitive essence consists of direct combat between two competing athletes^{2, 3)}. Most sports are

closely linked with the risk of injury^{2, 3)}. A sports injury is defined as damage to part of the body resulting in inability to practice or compete normally⁴⁾. Because combat sports frequently involve striking, throwing, or immobilizing an opponent, some researchers suggest that they are more dangerous for athletes than other sports⁵⁾. Almost all injuries involved in combat sports are caused by mechanical energy, and this manifests as musculoskeletal injuries. Musculoskeletal injuries usually occur when the body experiences overload through accident or overuse^{5, 6)}. Many sporting events in Korea revolve around combat sports such as judo, wrestling, kendo, boxing, taekwondo, and ssireum. Ssireum, also called Korean wrestling, is a form of Korean martial arts in which two athletes use strength and various skills to throw their opponent to the ground⁷⁾. Combat sports can be

^{a)}The first 2 authors (Noh JW and Park BS) contributed equally to this work.

*Corresponding author. Junghwan Kim (E-mail: junghwankim3@yongin.ac.kr)

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classified into two types: strike and non-strike (throwing or immobilizing an opponent). Strike sports involve striking an opponent directly by kicking or punching or by using a weapon. Taekwondo, boxing, and kendo are examples of strike sports. The rules of taekwondo, or rather gyorugi, state that a competitor can only score by striking his opponent in the chest using only his fists or by kicking his opponent's head and torso using only the part of the foot below the ankle^{8, 9}). Boxing is a contest that involves striking the body or head of an opponent by means of a punch¹⁰). The rules of kendo state that the head, wrist, waist, or throat of an opponent can be struck with a bamboo sword¹¹⁻¹³). Athletes who pursue strike sports wear protective equipment. Taekwondo athletes wear a guard on the head, torso, arms, legs, and groin, while kendo athletes are equipped with protective armor on the head, torso, and forearms. Boxers use gloves to reduce the risk of injury to their opponents^{8, 10-13}). Conversely, direct striking is not permitted in non-strike sports, so players do not generally wear protective equipment. Different rules apply in judo, wrestling, and ssireum, and the common goal of these sports is to overpower an opponent through force and skill^{7, 14-16}). Every combat sports event has physical or injury characteristics based on the combat method, rules, and skills used. Even within the same sport, there are differences according to playing style¹⁷⁻²⁰). Combat sports are the focus of much attention worldwide, and for this reason, there is a wealth of research available regarding the injuries sustained by combat athletes in various competitions. These data are typically classified according to event, injured body part, and the epidemiology of the injury. However, little research has been carried out on the playing style of combat athletes, especially in strike and non-strike sports. Our study aims to describe the characteristics of injuries sustained in strike and non-strike combat sports so that the data can be used in sports physiotherapy.

SUBJECTS AND METHODS

This study was conducted on 159 athletes in various combat sports. The participants included elite college players of the following sports: judo (47), ssireum (19), wrestling (13), kendo (30), boxing (16), and taekwondo (34). Of the participants, 133 were male and 26 were female. In the case of ssireum and boxing, all of the athletes were male. The volunteers had no physical or psychological conditions, and all of them provided informed written consent to participation in this study. For the purposes of the study, we divided the participants into two groups according to playing style: strike sports and non-strike sports. Kendo, boxing, and taekwondo are strike sports, while judo, ssireum, and wrestling are non-strike sports. A survey was conducted for each sport from August to October 2014. The questionnaire was filled out directly by the athletes under the supervision of a researcher. The tool used was an "injury questionnaire," which contained three queries based on the following information regarding the injury type:

1. Type of injury (muscular system)
2. Injured body part (cephalic, body, upper limb, lower limb)
3. Where and when the injury occurred and the aftermath

(when the injury occurred, when the athlete returned to exercise, recurrence of the injury, side effects, psychological reaction after the injury)

In the case of queries 1 and 2, more than one response was permitted in order to cover all injuries experienced by the athletes. "Injury" in this study was defined as any bodily damage that interfered with competition or training. No multiple choice questions were included in the questionnaire. Statistical analyses were conducted using the PASW Statistics software (version 18.0) to calculate averages and standard deviations. Data relating to the general characteristics of the athletes were expressed as the mean \pm standard error (SE), and these data were assessed using the Student's t-test. The significance level was set to $\alpha=0.05$. We also analyzed the frequency of injury in each sport, and crosstabs were created for each question using a χ^2 test and Fisher's exact test. In accordance with the terms of Resolution 5-1-20, December 2006, the protocol for the study was approved by the Committee of Ethics in Research of the University of Yongin. Furthermore, all volunteers provided informed consent for participation in the study^{7, 8, 10}).

RESULTS

The general characteristics of the participants are described in Table 1. All combat athletes had experienced musculoskeletal injuries except for one kendo athlete (Table 2). Skin injuries were most frequent among wrestlers in the case of non-strike sports and among boxers in the case of strike sports. There was a high incidence of nerve injuries such as neuralgia among the non-strike athletes; however, this was not statistically significant (Table 2). Tooth injuries were the most infrequent type in both groups. The order of frequency with regard to injury types was musculoskeletal injuries followed by skin, nerve, and tooth injuries in both groups (Table 2). In terms of musculoskeletal injuries, dislocation was the most frequent injury in non-strike athletes, and the difference between the groups was significant. Fracture was most common in the taekwondo athletes, followed by the boxers and judo athletes (Table 3). There was a higher incidence of ligament rupture among the ssireum athletes than among athletes of any other sport. Judo athletes were the second most affected group, followed by taekwondo athletes. Although the non-strike sports showed a higher incidence of ligament rupture than the strike sports, the difference was not statistically significant (Table 2). Muscle injury frequency was highest in the taekwondo athletes. Over half of all the athletes had experienced sprains, strains, and bruising, and most of the wrestlers had been injured in this way. The incidence of bruising was high in both the strike and the non-strike sports. The boxers and taekwondo athletes showed the most bruising injuries, followed by the ssireum and wrestling athletes. The incidence of herniated disc was similar in both groups, with wrestlers among the most affected (Table 3). There were differences in terms of injuries to the cephalic body parts, and neck injuries in particular were more frequent in the non-strike sports than in the strike sports. However, the incidence of neck injuries was similar in the kendo athletes and non-strike sports athletes. Boxers had experienced more injuries to the face and head than the other athletes (Table

Table 1. General characteristics of the combat sports players

Variable	Judo	Ssireum	Wrestling	Kendo	Boxing	Taekwondo
Gender (M/F)						
Male (%)	34 (72.3)	19 (100.0)	9 (69.2)	27 (90.0)	16 (100.0)	28 (82.4)
Female (%)	13 (27.7)	-	4 (30.8)	3 (10.0)	-	6 (17.6)
Total (%)	47 (100.0)	19 (100.0)	13 (100.0)	30 (100.0)	16 (100.0)	34 (100.0)
Age (yrs)	20.4±0.2	19.9±0.3	20.1±0.3	20.0±0.2	19.4±0.3	19.8±0.3
Height (cm)	173.0±1.3	178.1±1.1*	169.3±4.5 [†]	174.5±1.1 ^{†#}	173.4±2.9 [†]	178.3±1.0 ^{**#§}
Weight (kg)	79.4±2.8	96.1±5.4*	77.9±4.5 [†]	70.8±1.1 ^{**†}	67.9±2.9 ^{**†}	69.4±1.7 ^{**†}
BMI (kg/cm ²)	26.2±0.6	30.2±1.5*	26.9±1.0	23.2±0.3 ^{**†#}	22.5±0.7 ^{**†#}	21.7±0.3 ^{**†#}
Career (yrs)	9.2±0.4	9.3±0.5	5.9±0.5	8.6±0.5	6.0±0.7	7.8±0.4
Training time						
Running (h/day)	1.7±0.1	1.3±0.1	1.3±0.2	0.6±0.1	1.0±0.3	1.1±0.1
Major (h/day)	2.0±0.0	2.1±0.1	2.2±0.2	3.7±0.2	1.9±0.1	2.6±0.1
WT (h/day)	1.4±0.1	0.8±0.1	1.1±0.1	0.4±0.1	1.0±0.1	0.8±0.1
Total (h/day)	5.2±0.8	4.3±0.2	4.6±0.4	4.7±0.2	4.1±0.2	4.6±0.2
Days/week (days)	6.0±0.5	5.1±0.1	5.3±0.1	5.6±0.1	5.5±0.1	6.0±0.1

All data are presented as the mean±SE. M: male player; F: female player; BMI: body mass index; WT: weight training. *†#§: p < 0.05.

Table 2. Crosstabs of the type of injury and sports players

Variable		Musculoskeletal injuries	Skin injuries	Nerve injuries	Tooth injuries	Etc.
Non-strike sports	Judo (%)	47 (100.0)	9 (19.1)	8 (17.0)	3 (6.4)	0 (0.0)
	Ssireum (%)	19 (100.0)	6 (31.6)	4 (21.1)	1 (5.3)	0 (0.0)
	Wrestling (%)	13 (100.0)	5 (38.5)	4 (30.8)	2 (15.4)	0 (0.0)
Strike sports	Kendo (%)	25 (96.2)	5 (19.2)	4 (15.4)	0 (0.0)	0 (0.0)
	Boxing (%)	16 (100.0)	4 (25.0)	2 (12.5)	3 (18.8)	0 (0.0)
	Taekwondo (%)	34 (100.0)	6 (17.6)	3 (8.8)	4 (11.8)	0 (0.0)
Non-strike sports (%)		79 (100.0)	20 (25.3)	16 (20.3)	6 (7.6)	0 (0.0)
Strike sports (%)		75 (98.7)	15 (19.5)	9 (11.7)	7 (9.1)	0 (0.0)
x ² (p)		- (0.490) ^a	0.763 (0.382)	2.126 (0.145)	0.114 (0.735)	-

^aFisher's exact test. *p < 0.05

Table 3. Crosstabs of the type of musculoskeletal injury and sports players

Variable		Dislocation	Fracture	Rupture of ligament	Rupture of muscle	Sprain or strain	Bruise	Herniated disc	Etc.
NSS	Judo (%)	9 (19.6)	23 (50.0)	27 (58.7)	10 (21.7)	22 (47.8)	23 (50.0)	7 (15.2)	0 (0.0)
	Ssireum (%)	1 (5.6)	2 (11.1)	13 (72.2)	6 (33.3)	8 (44.4)	12 (66.7)	4 (22.2)	1 (5.6)
	Wrestling (%)	3 (25.0)	4 (33.3)	4 (33.3)	4 (33.3)	11 (91.7)	8 (66.7)	5 (41.7)	1 (8.3)
SS	Kendo (%)	0 (0.0)	2 (8.0)	7 (28.0)	3 (12.0)	15 (60.0)	10 (40.0)	7 (28.0)	4 (16.0)
	Boxing (%)	1 (6.3)	9 (56.3)	6 (37.5)	3 (18.8)	11 (68.8)	12 (75.0)	4 (25.0)	0 (0.0)
	Taekwondo (%)	2 (5.9)	23 (67.6)	19 (55.9)	18 (52.9)	20 (58.8)	24 (70.6)	6 (17.6)	0 (0.0)
NSS (%)		13 (16.9)	29 (37.7)	44 (57.1)	20 (26.0)	41 (53.2)	43 (55.8)	16 (20.8)	2 (2.6)
SS (%)		3 (4.0)	34 (45.3)	32 (43.7)	24 (32.0)	46 (61.3)	46 (61.3)	17 (22.7)	4 (5.3)
x ² (p)		6.695 (0.010) [*]	0.921 (0.337)	3.185 (0.074)	0.671 (0.413)	1.015 (0.314)	0.472 (0.492)	0.080 (0.778)	- (0.439) ^a

^aFisher's exact test. NSS: non-strike sports; SS: strike sports. *p < 0.05

4). In general, body part injuries were less frequent than other injuries in all sports, with the exception of lower back injuries. The ssireum athletes showed the highest frequency

of lower back injuries, followed by the kendo and wrestling athletes (Table 5). There were no significant differences between the two groups in terms of body part injuries. Many

Table 4. Crosstabs of region of cephalic injury and sports players

Variable		Neck	Face	Head	Etc.
Non-strike sports	Judo (%)	8 (21.1)	4 (10.5)	2 (5.3)	0 (0.0)
	Ssireum (%)	7 (43.8)	1 (6.3)	1 (6.3)	0 (0.0)
	Wrestling (%)	4 (30.8)	2 (15.4)	7.1 (7.7)	0 (0.0)
Strike sports	Kendo (%)	8 (29.6)	0 (0.0)	0 (0.0)	0 (0.0)
	Boxing (%)	3 (18.8)	7 (43.8)	3 (18.8)	0 (0.0)
	Taekwondo (%)	0 (0.0)	4 (12.5)	0 (0.0)	0 (0.0)
Non-strike sports (%)		19 (28.4)	7 (10.4)	4 (6.0)	0 (0.0)
Strike sports (%)		11 (14.7)	11 (14.7)	3 (4.0)	0 (0.0)
χ^2 (p)		3.981 (0.046) ^a	0.569 (0.451)	- (0.707) ^a	-

^aFisher's exact test. *p < 0.05**Table 5.** Crosstabs of region of body injury and sports players

Variable		Abdomen	Chest	Low back	Back	Etc.
Non-strike sports	Judo (%)	1 (2.6)	2 (5.3)	11 (28.9)	1 (2.6)	1 (2.6)
	Ssireum (%)	0 (0.0)	1 (6.3)	11 (68.8)	2 (12.5)	0 (0.0)
	Wrestling (%)	0 (0.0)	2 (15.4)	7 (53.8)	1 (7.7)	1 (7.7)
Strike sports	Kendo (%)	1 (3.7)	0 (0.0)	15 (55.6)	2 (7.4)	0 (0.0)
	Boxing (%)	0 (0.0)	1 (6.3)	6 (37.5)	1 (6.3)	0 (0.0)
	Taekwondo (%)	0 (0.0)	1 (3.1)	9 (28.1)	0 (0.0)	1 (3.1)
Non-strike sports (%)		1 (1.5)	5 (7.5)	29 (43.3)	4 (6.0)	2 (3.0)
Strike sports (%)		1 (1.3)	2 (2.7)	30 (40.0)	3 (4.0)	1 (1.3)
χ^2 (p)		- (1.000) ^a	- (0.255) ^a	0.157 (0.692)	- (0.707) ^a	- (0.602) ^a

^aFisher's exact test. *p < 0.05

different upper limb injuries were evident in both groups. Shoulder and elbow injuries were frequent in the non-strike sports group, and injuries to the right wrist and hands were less frequent in the strike sports group. There was a lower incidence of elbow injuries in the ssireum athletes than in the athletes pursuing other non-strike sports (left=12.5%; right=6.3%). Wrist injuries were more common in the kendo (left=55.6%; right=48.1%) and boxing athletes (left=50.0%; right=50.0%) than in the athletes pursuing other sports, while hand injuries were highest in the boxers. No major differences between the groups were identified in terms of finger injuries, which were most frequent in judo, followed by boxing, taekwondo, and wrestling (Table 6). There was no significant difference between the groups in terms of lower limb injuries. Lower limb injuries were the most common body part injury in both groups. Furthermore, there were no significant differences in terms of injuries to left and right knees and toes, but the frequency was slightly higher in the non-strike sports group. Injuries to the left and right ankles were the most common lower limb injuries in both groups. Hip joint injuries, on the other hand, were the least common lower limb injuries in both groups. Overall, there was a higher incidence of lower limb injuries in taekwondo athletes than in the other sports (Table 7). In the responses regarding what the athletes were doing at the time the injuries occurred, training fights (75.19%) were cited first, followed by competition (12.40%), weight training (5.43%), running (3.10%), stretching (2.33%), and other (1.55%). In terms of

the causes of injury, violent training was the most common (45.37%), followed by chronic fatigue (13.89%), lack of warm-up and cooldown exercises (13.89%), excessive desire (12.96%), too much stress (4.63%), other causes (3.70%), distraction (2.78%), excessive weight reduction (0.93%), foul by an opponent (0.93%), and unreasonable demands by a coach (0.93%). The responses regarding when the athletes returned to exercise after injury were as follows: after partial treatment (56.00%), after complete recovery (19.33%), after a few days of rest (14.67%), and immediately after receiving the injury (10.00%). The responses regarding why injured athletes returned early included greed (48.51%), walking on eggshells around colleagues (20.15%), coach pressure (16.42%), and other (14.93%). In response to whether they suffered side effects after injury, 85.81% of the athletes answered "yes", while 14.19% answered "no". Similarly, in response to whether they relapsed after injury, 84.62% of the athletes answered "yes", while 15.38% answered "no". With regard to the athletes' psychological reactions after injury, their main concern was relapse, followed by difficulty engaging in exercise, loss of ability, other concerns, and concern that a coach would react negatively.

DISCUSSION

In this study, we surveyed the characteristics of injuries in combat sports and found that the physical characteristics differed among the athletes in each sport. Almost all of the

Table 6. Crosstabs of region of upper limb injury and sports players

Variable		Left shoulder	Right shoulder	Left elbow	Right elbow	Left wrist	Right wrist	Hands	Fingers	Etc.
NSS	Judo (%)	16 (42.1)	17 (44.4)	12 (31.6)	17 (44.7)	12 (31.6)	8 (21.1)	4 (10.5)	25 (65.8)	0 (0.0)
	Ssireum (%)	5 (31.3)	8 (50.0)	2 (12.5)	1 (6.3)	7 (43.8)	6 (37.5)	0 (0.0)	5 (31.3)	0 (0.0)
	Wrestling (%)	8 (61.5)	7 (53.8)	7 (53.8)	7 (53.8)	3 (25.0)	3 (23.1)	1 (7.7)	6 (46.2)	1 (7.7)
SS	Kendo (%)	2 (7.4)	4 (14.8)	5 (18.5)	3 (11.1)	15 (55.6)	13 (48.1)	3 (11.1)	3 (11.1)	0 (0.0)
	Boxing (%)	5 (33.3)	5 (31.3)	4 (25.0)	4 (25.0)	8 (50.0)	8 (50.0)	7 (43.8)	10 (62.5)	0 (0.0)
	Taekwondo (%)	2 (6.3)	1 (3.1)	2 (6.3)	2 (6.3)	10 (31.3)	10 (31.3)	9 (28.1)	19 (59.4)	1 (3.1)
NSS (%)		29 (43.3)	32 (47.8)	21 (31.3)	25 (37.3)	22 (33.3)	17 (25.4)	5 (7.5)	36 (53.7)	1 (1.5)
SS (%)		9 (12.2)	10 (13.3)	11 (14.7)	9 (12.0)	33 (44.0)	31 (41.3)	19 (25.3)	32 (42.7)	1 (1.3)
χ^2 (p)		17.299 (0.000)*	20.137 (0.000)*	5.638 (0.018)*	12.452 (0.000)*	1.679 (0.195)	4.028 (0.045)*	8.047 (0.005)*	1.736 (0.188)	- (1.000) ^a

^aFisher's exact test. NSS: non-strike sports; SS: strike sports. *p < 0.05

Table 7. Crosstabs of region of lower limb injury and sports players

Variable		Left knee	Right knee	Left ankle	Right ankle	Left hip	Right hip	Left toes	Right toes	Etc.
NSS	Judo (%)	20 (52.6)	19 (50.0)	24 (63.2)	20 (52.6)	4 (10.5)	4 (10.5)	15 (39.5)	15 (39.5)	0 (0.0)
	Ssireum (%)	7 (43.8)	8 (50.0)	12 (75.0)	10 (62.5)	1 (6.3)	1 (6.3)	4 (25.0)	5 (31.3)	0 (0.0)
	Wrestling (%)	7 (53.8)	9 (69.2)	7 (53.8)	6 (46.2)	1 (7.7)	1 (7.7)	0 (0.0)	1 (7.7)	2 (15.4)
SS	Kendo (%)	10 (37.0)	12 (44.4)	17 (63.0)	13 (48.1)	1 (3.7)	1 (3.7)	4 (14.8)	4 (14.8)	0 (0.0)
	Boxing (%)	5 (31.3)	6 (37.5)	6 (37.5)	8 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (6.3)	1 (6.3)
	Taekwondo (%)	14 (43.8)	17 (53.1)	25 (78.1)	24 (75.0)	6 (18.8)	5 (15.6)	8 (25.0)	9 (28.1)	4 (12.5)
NSS (%)		34 (50.7)	36 (53.7)	43 (64.2)	36 (53.7)	6 (9.0)	6 (9.0)	19 (28.4)	21 (31.3)	2 (3.0)
SS (%)		29 (38.7)	35 (46.7)	48 (64.0)	45 (60.0)	7 (9.3)	6 (8.1)	12 (16.0)	14 (18.7)	5 (6.7)
χ^2 (p)		2.092 (0.148)	0.706 (0.401)	0.000 (0.982)	0.567 (0.451)	0.006 (0.938)	0.32 (0.857)	3.167 (0.075)	3.062 (0.080)	- (0.447) ^a

^aFisher's exact test. NSS: non-strike sports; SS: strike sports. *p < 0.05

athletes had experienced musculoskeletal injuries. Skin and nerve injuries were the next most common, while tooth injuries occurred least frequently in the combat athletes. We compared combat sports events according to playing styles, and the results showed that there were obvious differences between the two groups. Non-strike sports showed a greater incidence of dislocation than strike sports, while sprains, strains, and bruises were common in both groups. In terms of body parts injured, there were major differences between the groups regarding upper limb injuries. In the case of most upper limb injuries, the differences were statistically significant. Finger injuries in the judo athletes generally occurred when they tried to catch their opponents using skill. Injuries to the left and right shoulders and elbows were more frequent in the non-strike sports, whereas the right wrist and hands were more frequently injured in the strike sports. These results can also be seen in other studies. According to research on sports injuries in pediatrics, children learning judo are more prone to upper limb injuries than other children, while children learning taekwondo are more prone to lower limb injuries than other children^{5, 17}). Some researchers suggest that judo and wrestling athletes are more likely to incur upper limb injuries than lower limb injuries^{21, 22}). Nevertheless, the same studies indicate that elbow injuries

are less common in ssireum athletes than in athletes pursuing other sports because, unlike judo and wrestling, ssireum does not involve attempting to catch an opponent during a match. Also, ssireum athletes grab hold of the satba (a cloth-sash tied around the waist and thigh) of their opponents before their matches begin⁷). Hand and finger injuries are more frequent in boxing, judo, and taekwondo athletes than in those pursuing other sports. We believe that the fists of boxers sustain a direct impact when they strike their opponents. However, some studies suggest that the reason for hand injuries in taekwondo athletes may be attributable to their skill in protecting their heads and necks using their upper limbs²³). In this study, finger injuries were particularly common in the judo athletes, which was in line with the results of other studies on judo injuries^{4, 21}). Finger injuries typically occur in judo athletes when they try to catch opponents using skill. Other differences were also evident between the two groups. For example, neck injuries were more frequent in the non-strike sports than in the strike sports, but there were no differences between the groups in terms of cephalic injuries. Some studies on combat sports injuries indicate that judo and boxing athletes incur many severe head and neck injuries^{15, 24}). However, we did not conduct a survey on severe injuries such as brain hemorrhage and spinal cord injury be-

cause the participants in our study were young athletes and currently participating in their sports. Lower limb injuries were more frequent than other types in both groups. There was a relatively wide weight range among the participants of the non-strike group, and injuries to both knees were less frequent in this group, but the difference was not statistically significant. More than half of the judo and wrestling athletes had experienced knee injuries. In line with other studies, we found that the most frequent injury in athletes pursuing two events was injury to the medial collateral ligament^{25, 26}. Injuries in combat sports were most likely to occur during training fights, and the athletes who had incurred injuries felt that the most common cause was violent training. To prevent injury in combat sports, sports physical therapists need to pay particular attention to athletes during training. Of the athletes who returned to training following injury, only 19.33% of them had completed their full treatment. Most returned to training early due to greed. Almost all of the athletes who had been injured experienced side effects and relapse of their injuries. This is why many researchers emphasize the importance of injury prevention education for athletes^{18, 27}. To summarize our study, the type and location of the injury differs according to playing style in combat sports. In this regard, dislocation and injuries to the neck, shoulders, and elbows were found to be more frequent in non-strike sports, while injuries to the wrists and hands were found to be more frequent in strike sports. Sprains, strains, bruises, and injuries to the lower limbs were very common in both groups. Our data is based on a small sample size and therefore does not include all the injuries that may be incurred in combat sports. However, we suggest that the characteristics of injuries in combat sports could be classified according to playing style. This would enable our study to provide physical therapists and researchers with information on prevention of injury. Sports physical therapists need to study precautions and interventions regarding sports injuries according to the playing style of athletes. In addition, we recommend further systematic studies on the various playing styles in combat sports in order to assist sports physical therapists in devising interventions^{28, 29}.

REFERENCES

- Franchini E, Brito CJ, Artioli GG: Weight loss in combat sports: physiological, psychological and performance effects. *J Int Soc Sports Nutr*, 2012, 9: 52. [Medline] [CrossRef]
- Cynarski WJ, Kudlacz M: Injuries in martial arts and combat sports—a comparative study. *Arch Budo*, 2008, 4: 91–97.
- Kudlacz M, Cynarski WJ: Injuries in martial arts and combat sports—preliminary results of research. *Arch Budo*, 2007, 3: 62–67.
- Perez-Turpin JA, Penichet-Tomas A, Suarez-Llorca C, et al.: Injury incidence in judokas at the Spanish National University Championship. *Arch Budo*, 2013, 9: 211–218.
- Pappas E: Boxing, wrestling, and martial arts related injuries treated in emergency departments in the United States, 2002–2005. *J Sports Sci Med*, 2007, 6: 58–61. [Medline]
- Saragiotto BT, Di Piero C, Lopes AD: Risk factors and injury prevention in elite athletes: a descriptive study of the opinions of physical therapists, doctors and trainers. *Braz J Phys Ther*, 2014, 18: 137–143. [Medline]
- Noh JW, Kim JH, Kim JH: Somatotype analysis of Korean wrestling athletes compared with non-athletes for sports health sciences. *Toxicol Environ Health Sci*, 2013a, 5: 163–168. [CrossRef]
- Noh JW, Kim JH, Kim JH: Somatotype analysis of elite taekwondo athletes compared with non-athletes for sports health sciences. *Toxicol Environ Health Sci*, 2013b, 5: 189–196. [CrossRef]
- Kazemi M: Relationships between injury and success in elite Taekwondo athletes. *J Sports Sci*, 2012, 30: 277–283. [Medline] [CrossRef]
- Noh JW, Kim JH, Kim MY, et al.: Somatotype analysis of elite boxing athletes compared with nonathletes for sports physiotherapy. *J Phys Ther Sci*, 2014, 26: 1231–1235. [Medline] [CrossRef]
- Yotani K, Tamaki H, Kirimoto H, et al.: Response time and muscle activation patterns of the upper limbs during different strikes in kendo. *Arch Budo*, 2013, 9: 101–106. [CrossRef]
- Koshida S, Matsuda T: Ankle and knee joint coordination in sagittal plane during kendo strike-thrust motion in healthy kendo athletes. *Arch Budo*, 2013, 9: 109–116. [CrossRef]
- Kon M, Tanabe K, Akimoto T, et al.: Reducing exercise-induced muscular injury in kendo athletes with supplementation of coenzyme Q10. *Br J Nutr*, 2008, 100: 903–909. [Medline] [CrossRef]
- Noh JW, Kim JH, Kim JH: Somatotype analysis of elite judo athletes compared with non-athletes for sports health sciences. *Toxicol Environ Health Sci*, 2014a, 6: 99–105. [CrossRef]
- Kamitani T, Nimura Y, Nagahiro S, et al.: Catastrophic head and neck injuries in judo players in Japan from 2003 to 2010. *Am J Sports Med*, 2013, 41: 1915–1921. [Medline] [CrossRef]
- Noh JW, Kim JH, Kim JH: Somatotype analysis of freestyle wrestlers compared with non-athletes for health science research. *Toxicol Environ Health Sci*, 2014b, 6: 244–250. [CrossRef]
- Yard EE, Knox CL, Smith GA, et al.: Pediatric martial arts injuries presenting to Emergency Departments, United States 1990–2003. *J Sci Med Sport*, 2007, 10: 219–226. [Medline] [CrossRef]
- Pieter W: Martial arts injuries. *Med Sport Sci*, 2005, 48: 59–73. [Medline]
- Yamaner F, Imamoglu O, Atan T, et al.: The injuries of Turkish national free-style and Graeco-Roman wrestlers. *Med Sport*, 2012, 65: 549–561.
- Sousa P, Marquez M, Uliani R, et al.: Incidence of injuries to the lower limbs joints in kung fu athletes. *Arch Budo*, 2010, 6: 137–142.
- Poecoco E, Ruedl G, Stankovic N, et al.: Injuries in judo: a systematic literature review including suggestions for prevention. *Br J Sports Med*, 2013, 47: 1139–1143. [Medline] [CrossRef]
- Kordi R, Ziaee V, Rostami M, et al.: Sports injuries and health problems among wrestlers in Tehran. *J Pak Med Assoc*, 2012, 62: 204–208. [Medline]
- Ziaee V, Rahmani SH, Rostami M: Injury rates in Iranian taekwondo athletes; a prospective study. *Asian J Sports Med*, 2010, 1: 23–28. [Medline]
- Nagahiro S, Mizobuchi Y: Current topics in sports-related head injuries: a review. *Neurol Med Chir (Tokyo)*, 2014, 54: 878–886. [Medline] [CrossRef]
- Roach CJ, Haley CA, Cameron KL, et al.: The epidemiology of medial collateral ligament sprains in young athletes. *Am J Sports Med*, 2014, 42: 1103–1109. [Medline] [CrossRef]
- Majewski M, Susanne H, Klaus S: Epidemiology of athletic knee injuries: a 10-year study. *Knee*, 2006, 13: 184–188. [Medline] [CrossRef]
- Witkowski K, Maslinski J, Stefaniak T, et al.: Causes of injuries in young female judokas. *Arch Budo*, 2012, 8: 109–114. [CrossRef]
- Lee LK, Kim JH, Kim MY, et al.: A pilot study on pain and the upregulation of myoglobin through low-frequency and high-amplitude electrical stimulation-induced muscle contraction. *J Phys Ther Sci*, 2014, 26: 985–988. [Medline] [CrossRef]
- Lee LK, Kim JH, Kim MY, et al.: A review of signal transduction of endothelin-1 and mitogen-activated protein kinase-related pain for nanophysical therapy. *J Phys Ther Sci*, 2014, 26: 789–792. [Medline] [CrossRef]