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Nine year longitudinal retrospective study of Taekwondo injuries

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This retrospective longitudinal study aims to describe reported Taekwondo injuries and to examine associations between competitor experience level, age and gender, and the type, location, and mechanism of injury sustained. Additionally, we examined whether recent rule changes concerning increased point value of head shots in adult Taekwondo competition had affected injury incidence.

This study was a summation of 9 years of data of competition injury reports, which included 904 injury reports spanning 58 individual competitions. The data was collected on standardized injury reports at time of injury during competition. Care was provided to the athletes, but the type of care provided was not included in the study. Participants included athletes injured during competition who sought care by the health care team, and for whom an injury report was filled out. The data analysis was performed at the Canadian Memorial Chiropractic College.

The three most common locations of presenting injury were the head (19%), foot (16%), and thigh (9%). The most common mechanism of presenting injury was found to be a defensive kick (44%), followed by an offensive kick (35%). The most commonly diagnosed injuries were contusions (36%), sprains (19%), and strains (15%). Coloured belts had a higher incidence of contusions, while black belts sustained more joint irritation injuries. Black belts were more likely to suffer multiple injuries. Colored belts suffered more injuries while receiving a kick, while black belts had a larger influence of past

Cette étude rétrospective longitudinale a pour but de décrire les blessures déclarées de taekwondo et d'examiner les associations entre le niveau d'expérience des compétiteurs, leur âge et leur sexe, ainsi que le type, l'endroit et le mécanisme de la blessure subie. De plus, nous avons examiné si des changements récents aux règlements pour augmenter la valeur en points des coups à la tête lors d'une compétition de taekwondo entre adultes ont eu des répercussions sur la fréquence des blessures.

Cette étude était un résumé de 9 ans de données provenant de rapports sur les blessures subies lors de compétitions, qui comprenaient 904 rapports de blessures pour 58 compétitions individuelles. Les données ont été recueillies lors de rapports de blessures normalisés tout de suite après la blessure lors de la compétition. Des soins ont été prodigués aux athlètes, mais le type de soins fourni n'a pas été inclus dans l'étude. Les participants comprenaient des athlètes blessés lors d'une compétition qui ont reçu des soins de la part de l'équipe soignante et pour qui on a rempli un rapport de blessure. L'analyse des données a été réalisée au Canadian Memorial Chiropractic College.

Les trois endroits les plus communs de blessure étaient la tête (19 %), le pied (16 %) et la cuisse (9 %). Le mécanisme le plus commun ayant provoqué la blessure était un coup de pied défensif (44 %), suivi par un coup de pied offensif (35 %). Les blessures les plus souvent diagnostiquées étaient les contusions (36 %), les entorses (19 %) et les foulures (15 %). Les athlètes avec ceinture

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history of injury. We found no significant difference in location or type of injury when comparing pre versus post rule change. The most common locations of injury are head, foot, and thigh respectively, and are areas for concern when considering preventative measures. Colour belt competitors are more likely to sustain contusions, which the authors believe is due to more aggressive tactics and lack of control. Those more likely to be injured tend to be younger than 18 years. Recent rule changes have no significant effect on head injuries.
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KEY WORDS: Taekwondo, injury, athlete, competition

de couleur présentaient une plus grande fréquence de contusions, alors que les athlètes avec ceinture noire présentaient plus d'irritation des articulations. Les athlètes avec ceinture noire étaient plus enclins à subir des blessures multiples. Les athlètes avec ceinture colorée souffraient de plus de blessures en recevant un coup de pied, alors que les athlètes avec ceinture noire avaient une plus grande influence de leurs antécédents de blessures. Nous n'avons pas découvert de différence importante vis-à-vis de l'endroit ou du type de blessure lors de comparaisons entre avant le changement aux règlements et après. Les endroits les plus communs pour les blessures sont la tête, le pied et la cuisse respectivement et sont à considérer lors de l'établissement de mesures préventives. Les compétiteurs avec ceinture colorée ont de plus fortes chances de subir des contusions; les auteurs croient que cela s'explique par des tactiques plus agressives et un manque de contrôle. Les personnes le plus à risque d'être blessées sont celles de moins de 18 ans. Les récents changements aux règlements n'ont pas d'effets importants sur les blessures à la tête.
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MOTS CLÉS : taekwondo, blessure, athlète, compétition

Introduction

Taekwondo is a Korean martial art practiced in over 184 countries.[1] The sport gained full medal status at the 2000 Olympics in Sydney, Australia,[1] and draws participants of all ages due to its perceived fitness benefits and popularity. A beginner starts at a rank of 'white belt' and when he or she has achieved sufficient proficiency of Taekwondo skills, they move through several higher ranks, respectively the colored belts (In increasing rank: Yellow, Orange, Green, Purple, Blue, Brown, Red), and black belts (with increasing rank based on Dan level, from 1st to 9th). To qualify for provincial tournament the athlete has to hold a first degree black belt from the WTF and has to weigh in the day before the tournament within the weight category they had applied to. Local tournaments have no such stipulations, though athletes are segregated by gender, age, and weight. Points in competition are awarded for full contact kicks to the body and head. A match consists of three rounds of two minutes each, and requires cardiovascular and muscular endurance. Due to the physical demands imposed on the athlete and the forces involved in full contact sparring, injury risk must be addressed.

It is plausible to reason that more training should correlate with lower injury incidence, and this is supported by research indicating a significant inverse relationship between children's Taekwondo rank and their aggression.[2] Martial arts athletes practice between two to four times per week and all must demonstrate a level of proficiency to advance in rank.[3] Thus, improvement of technique application in a competition setting should decrease the athlete's risk for injury during a match. However, as skill level increases, so do physical demands during combat, as well as force generated. More skilled athletes are likely to use dangerous techniques or execute fundamental ones with greater strength and speed. It is

therefore also possible that injury incidence may be higher in elite athletes. Interestingly, a recent study of karate injuries found that injury incidence increased with competitor rank, and with number of years practicing.[4]

Differences in injury rates between young and adult Taekwondo athletes have been studied in the past, and Beis et al 2001 found that young competitors, male or female, were more likely to sustain injury during competition than their adult counterparts.[5] It is likely that young Taekwondo athletes require extra safety precautions, for example, greater referee vigilance or extra protective equipment.

Previous studies have shown gender differences in Taekwondo with respect to type and mechanism of injury and injury rates. A recent study found greater rates of injury in male black belt competitors, and reported concussion injuries in male competitors only.[6] Previous studies have also noted increased force generation and aggression in male competitors.[7]

Although recent studies have found that the most common Taekwondo injury is that of the lower limb,[6] much attention is given to head injury, most likely owing to the severity of such trauma. This is interesting, as the frequency of head blows and concussions is reported to be high in Taekwondo.[8] Kicks are allowed to the head region, excluding the posterior aspect. The incidence of cerebral concussions in Taekwondo was reported by Zemper and Pieter in 1994 to be more than 2 times greater than in college football games, based on number of exposures.[9] In 2003, rule changes introduced an increase in point value of successful head contacts in adult competition to 2-points, compared to a standard 1-point value for kicks to the torso, plus an additional point for an eight-count knockdown.[1] This likely adds incentive to score more points via head strikes and thereby increases the risk of head injury.

The most common diagnoses reported in the literature for Taekwondo athletes are contusions and lacerations, followed by sprains and strains, knee lesions, broken limbs, and broken noses.[10,11] A recent study ranked the top 5 injuries as: sprain, joint dysfunction, contusion, laceration and strain, with concussion a close 6th.[6] The most common mechanism of injury in Taekwondo is receiving a kick, followed by delivering a kick.[10,11]

Past research has focused on injury incidence,[5,6,9,12,13] and the physical characteristics and training habits that predispose athletes to injury.[2,14,15,16] This study attempts to discern the injury incidence in Canadian provincial level Taekwondo competition and to describe the effect of recent rule changes and athlete experience on the types, locations, and mechanisms of injury.

Method

The sample population consisted of male and female Taekwondo athletes of all experience and age levels who competed in Canadian provincial and local interclub tournaments over the last 9 years, suffered an injury and sought care from the health care team at time of competition. For the purposes of this study, an athlete was considered injured if any of the following conditions applied: 1) any circumstance that forced the Taekwondo athlete to leave the competition; 2) any circumstance for which the referee or athlete had to stop competition; 3) any circumstance for which the athlete requested medical attention.[17]

Injuries were recorded on an injury form[6] describing the athlete as well as the nature, site, severity, and mechanism of injury. The injury reports were used for medical record-keeping purposes, and were later used as part of this study. The data was not initially collected for research purposes. Study data included 904 injury reports spanning 58 competitions. The data set consisted of 664 competitors, some suffering single and some suffering multiple injuries.

The study data was gathered retrospectively via injury reports over a 9 year period. The injury forms[6] were used to provide care for the athletes, and documentation of injuries was mandatory as per Ontario law. Oral or written informed consent for treatment was obtained. With an underage athlete, consent for treatment was obtained through the parents or guardian. The first author (the health care provider for these athletes) was the only person who had possession of the injury forms, keeping athlete identities confidential. Canadian Memorial Chiropractic College (CMCC) was the location of the study. The study passed an REB approval at CMCC (May 14, 07, certificate# = 0705X03).

The software program "R-project" (University of Auckland) was used to analyze the gathered data. Descriptive statistics were used to describe the sample in terms of demographic factors: population number, number of males and females, age range and mean age, and experience level expressed as belt rank. Means were

used to describe the outcome measures listed above (number of reported injuries, injury incidence, body part injured, injury type, and injury mechanism). The experience levels were compared by injury incidence, type, and mechanism using contingency tables and the Chi-square test for independence with Yate's continuity correction. The difference between the number of injuries and experience level was examined using a Chi-square test with Yate's continuity correction. The difference between pre and post rule change injury incidence was correlated using a Chi-square test with Yate's continuity correction. The authors used 0.05 as the standard for statistical significance.

Only the primary author had access to injury forms and identities. Photocopies were produced of injury reports with identities deleted, replaced with a unique number for data entry.

Results

The data included 532 single injury reports; 363 male, 142 female, and 27 without recorded gender. The data also included 367 repeat injury reports from 132 individual competitors; 84 male, 44 female, and 4 without recorded gender. The average number of injuries for athletes with repeat injuries was 2.78.

The age range for injured male competitors was 6 to 58 years old (mean = 18.9 years), with a median age of 16. The age range for females was 4 to 47 years old (mean = 17.1 years), with a median of 15. 16 reports lacked age information and were excluded, leaving 888 injuries. 510 injuries were competitors under age 18 and 378 injuries were competitors over age 18. In both age categories, males sustained the majority of injuries. In the under 18 category, there were 333 males and 177 females injured. In the over 18 category, there were 272 males and 106 females injured.

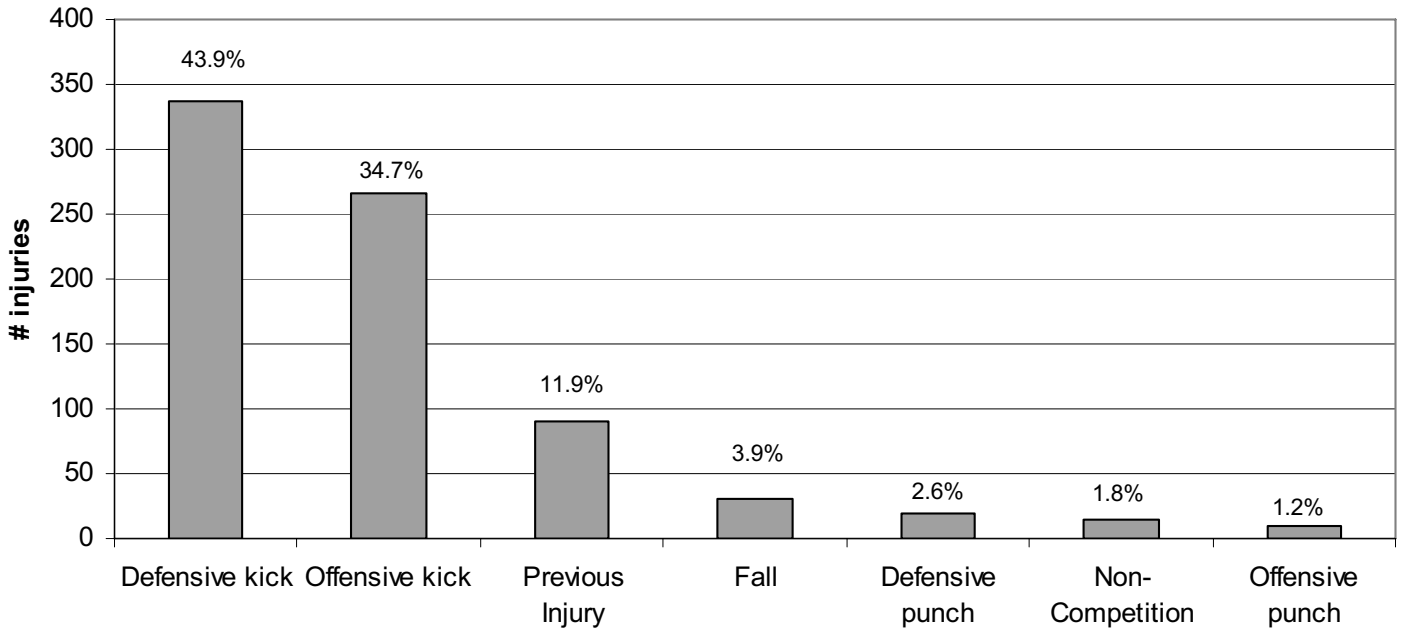
Of the 664 competitors, there were 447 males, 186 females, and 31 injury reports that lacked gender information and were excluded. Of the injured competitors, males sustained an equal proportion of total injuries as females, as well as head injuries (90) than females (33), and injuries received due to a kick, with 231 males and 97 females sustaining kick related injuries. Females were as likely to sustain injury from a defensive kick (n = 57) as from an offensive kick (n = 40), while males were almost twice as likely to sustain injury while receiving a kick (n = 147) than when delivering one (n = 84). The top three diagnoses for males were, in order: contusion (n = 125), sprain (n = 61), and strain (n = 45). Similar findings were discovered for females (contusions = 46, sprain = 23, strain = 22). An analysis on the effects of gender on location of injury yielded non-significant results ($X^2 = 3.97$, df = 3, p = 0.14). A similar finding was observed for gender and diagnosis of injury ($X^2 = 8.52$, df = 9, p = 0.48), as well as mechanism ($X^2 = 8.33$, df = 6, p = 0.21), and number of injuries sustained ($X^2 = 2.23$, df = 1, p = 0.14).

The mechanism of injury was not filled in for 137 of the injury forms and thus the analysis of mechanism of injury included 767 injuries (84.85% of total reports). The most common mechanism of injury was the defensive kick (337, 43.94%), followed by the offensive kick (266, 34.68%), and fall (30, 3.91%). However, 91 injuries (or 11.86%) may have been attributed to a previous injury. Full data with regard to injury mechanism is summarized in Figure 1. The defensive kick and punch categories included injuries sustained in the process of receiving a kick or a punch respectively. The offensive kick and punch categories included injuries sustained during the delivery of a kick or a punch respectively. A fall included injuries sustained during a fall, as long as injury was not sustained prior to the fall itself. For example, a competitor receiving a kick to the head, who then fell and sustained an ankle injury, would only have the ankle injury counted as a fall related injury. A non-significant trend of competitors aged over 35 sustaining an injury while receiving a punch was observed.

The location of injury was not reported in 13 of the injury reports, and thus the analysis of location of injury was based on 891 injuries (98.56% of total reports). The most common injured body region was the head (169 injuries, 18.86%), followed by foot (144 injuries, 16.16%), thigh (84 injuries, 9.43%), knee (75 injuries, 8.42%), ankle (71 injuries, 7.97%), back (68 injuries, 7.63%), and leg (55 injuries, 6.17%). Due to their proximity and functional relationship, foot and ankle injuries were pooled into a single category (215 injuries, 24.13%), making the foot and ankle the most likely area of injury. The categories were then pooled into functional categories of Upper Limb, Lower Limb, Head and Neck, and Torso. Full data is summarized in Table 2 and Table 3.

The injury diagnosis was missing in 24 of the reports and thus the analysis of injury diagnosis is based on 880

Figure 1 *Mechanism of injury*



injuries (97.35% of total reports). The most common diagnosed injury was contusion (319, 36.25%), followed by sprain (166, 18.86%), and strain (129, 14.66%). Table 4 summarizes the occurrence data.

For the purpose of correlation of experience and injury mechanism, diagnosis, and location, number of injuries, as well as pre and post rule change injury location, repeat injury reports were not used in the calculations, as the independence of a repeat injury could not be established. We could not be sure if a repeat injury was the result of a competitor's level of experience or simply due to the presence of recent injury itself. Thus the data set was pared down to a set of 659 injury reports, including the first injury suffered by a unique competitor. Black belt Dan level competitors were pooled into a single Black Belt category, as the Dan categories themselves were small. Of the 659 reports, 160 lacked identification of competitor experience level and were excluded from calculations pertaining to experience, leaving a pool of 499 injury reports (55.20% of total reports).

The location of injury was independent of the competitor's level of experience ($X^2 = 3.6615$, df = 3, p = 0.30).

Of the 499 injury reports included in the analysis, 63 did not include a mechanism of injury and were excluded for the purpose of experience versus mechanism calculations, and thus the following were performed on 436 injury reports (48.23% of total reports). The mechanism of injury was dependent of the competitor's experience level ($X^2 = 16.5053$, df = 6, p = 0.01128). A 2-sample test for equality of proportions with continuity correction was performed and it was observed that the proportion of injuries suffered during a defensive kick to all injuries was significantly higher for colored belt athletes (0.54) versus black belt athletes (0.40) ($X^2 = 6.5511$, df = 1, p = 0.01). The proportion of a history of injury versus all other types of injury sustained was significantly higher for black belt athletes (0.12) versus colored belt athletes (0.04) ($X^2 = 7.0923$, df = 1, p = 0.008). Black belt athletes (0.38) showed a trend towards injuries suffered during an offensive kick as compared to colored belts (0.30) ($X^2 = 1.9428$, df = 1, p = 0.1634). Table 5 offers a summary of the mechanism of injury versus experience level data.

Injury diagnosis was dependent of the competitor's experience level ($X^2 = 34.7444$, df = 9, $p < 0.001$). Again, a

Table 2 *Location of injury*

Location	Frequency	Percent
Head	169	18.86
Foot	144	16.16
Thigh	84	9.43
Knee	75	8.42
Ankle	71	7.97
Back	68	7.63
Leg	55	6.17
Neck	39	4.38
Toes	39	4.38
Hand	26	2.92
Trunk	19	2.13
Hip	19	2.13
Finger	17	2.02
Wrist	17	1.91
Shoulder	14	1.57
Forearm	13	1.46
Arm	11	1.23
Elbow	11	1.23
Total	891	100

Table 3 *Percentage of injury by body region*

Body Region	Frequency	Percent
Lower Limb	487	54.7
Head and Neck	208	23.3
Upper Limb	109	12.2
Torso	87	9.8

2-sample test for equality of proportions with continuity correction was performed and it was observed that the proportion of contusions to all injuries was significantly higher for colored belt competitors (0.48) versus black belt competitors (0.29) ($X^2 = 16.2138$, df = 1, $p < 0.001$). It was also observed that the proportion of joint dysfunctions/irritations to all injuries was significantly higher in black belt competitors (0.11) versus colored belt competitors (0.01) ($X^2 = 12.3451$, df = 1, $p < 0.001$). Table 6 summarizes the injury diagnosis versus experience level data.

Table 4 *Percentage of injuries by diagnosis*

Diagnosis	Frequency	Percent
Contusion	319	36.25
Sprain	166	18.86
Strain	129	14.66
Fracture	69	7.84
Joint Dysfunction	64	7.27
Concussion	52	5.91
Other	41	4.66
Laceration	18	2.05
Dislocation	11	1.25
Epistaxis	11	1.25

The presence of single versus multiple injuries was dependent on the experience level of the competitor, as black belt competitors sustained significantly more multiple injuries ($X^2 = 22.3792$, df = 1, $p < 0.001$). Table 7 summarizes the number of injuries versus Experience level data.

For the purpose of examining the effect of recent point scoring rule changes, a pool of 659 injury reports were used for the examination of rule change influences on injury location. Location of injury was found to be independent of whether injury occurred prior to the 2003 rule change, or after it ($X^2 = 0.3299$, df = 3, $p = 0.9543$). A subsequent proportional analysis was performed and no significance was determined.

Discussion

The present study is the first to examine injury incidence across a longitudinal time span of competition events, as well as to examine the effect of experience level on injury type, location and mechanism. The analyzed data spans from 1997 to 2006 and includes over 50 individual competitions. Such quantity of data should offer a clearer picture of injury incidence in Taekwondo competition.

Table 5 *Mechanism of injury versus Level of Experience*

Mechanism of injury	Color belt	Percent(%)	Black belt	Percent(%)
Defensive kick (statistically significant, $X^2 = 6.5511$, df = 1, p = 0.01)	73	53.68	120	40.00
Offensive kick	42	30.88	115	38.33
Defensive punch	8	5.88	7	2.33
Offensive punch	2	1.47	4	1.33
Fall	5	3.68	13	4.33
non competition injury	1	0.74	4	1.33
previous injury history (statistically significant, $X^2 = 7.0923$, df = 1, p = 0.008)	5	3.68	37	12.33
total	136	100	300	100

Table 6 *Diagnosed injuries versus Level of Experience*

Diagnosis of injury	Color belt	Percent(%)	Black belt	Percent(%)
Concussion (statistically significant, $X^2 = 16.2138$, df = 1, p < 0.001)	7	4.55	31	8.99
laceration	5	3.25	3	0.87
contusion	74	48.05	100	28.99
sprain	27	17.53	71	20.58
strain	20	12.99	55	15.94
fracture	9	5.84	26	7.54
dislocation	0	0.00	4	1.16
joint irritation /dysfunction (statistically significant, $X^2 = 12.3451$, df = 1 p < 0.001)	2	1.30	38	11.01
nose bleed	2	1.30	6	1.74
other	8	5.19	11	3.19
total	154	100.00	345	100.00

Table 7 *Number of injuries versus Level of Experience (statistically significant, $X^2 = 22.3792$, df = 1, p < 0.001)*

Number of injuries	Color belt	Percent(%)	Black belt	Percent(%)
single	140	90.91	245	71.01
multiple	14	9.09	100	28.99
total	154	100	345	100

The majority of injuries occurred in competitors under age 18, comparable to a previous study[5] which found that younger competitors, male or female, were more likely to sustain injury during competition than their adult counterparts. No statistical significance was found with respect to age and diagnosis, mechanism, and location of injury. There was, however, a trend that competitors aged 35 and older were more likely to sustain an injury while receiving a punch, possibly due to a reduced confidence in ability to perform a kick.

The data showed an equal proportion of reported injuries in males as females, though it must be restated that the sample only represents athletes who presented to the medical team for care, and not a complete sample of all competitors involved in each tournament. This differs from previous study[6] which reports higher injury rates in male black belt competitors. The study[6] also found concussion injuries in male competitors only. In our study, the proportion of males with head injuries did not differ from that of the females. The demographics of Taekwondo appear to consist of three times more men than women,[6,9,18] and this was reflected in our data set. In our data set, gender does not appear to affect the risk of sustaining injury, nor does it affect the diagnosis, mechanism, or location of injury. A recent meta-analysis by Lystad et al reported similar findings.[19]

The three most common locations of injury were the head, foot, and thigh. However, when the hip, thigh, knee, leg, ankle, foot and toe categories were summed into a lower limb category, these injuries exceeded head injuries for the black belt category only. Past research[6,8,9,19] cites the most common injury locations as the lower limb followed by the head. This is not surprising due to the use of the lower limb as the primary striking weapon, and the head's role as the primary target. In agreement with past study [11] the most common mechanisms of injury in this study were defensive kicks, and offensive kicks respectively. According to the literature,[10,11] contusions and lacerations occur significantly more frequently than other types of injuries. In this study, however, the most commonly diagnosed injuries were contusions, followed by sprains, then strains. Lacerations were not found to be common. As the literature states, the rate of non-serious injury is much higher than that of serious or life threatening injuries.[10,11,19] Thus, though the rates of injury have been reported to be high in Taekwondo, owing to its competitive nature, current rules and regulations adequately protect the athlete from serious injury.

The recent rule change increased the value of head shots in black belt competition, and was expected to cause an increase in head injuries. Contrary to this, no significant difference was found with regard to injury location or type when comparing injuries *pre-* versus *post-*rule change. It appears the 2003 rule change does not put competitors at increased risk of potentially serious head injury.

Prior to this study, the relationship between experience level and injury was not thoroughly examined. One could surmise that a novice is more prone to injury than a master due to the skill gap between the two. The novice athlete may compensate by increasing their aggression. Indeed, Skelton et al[2] found an inverse relationship between aggression and Taekwondo rank. Conversely, as skill level of a competitor increases, so does the physical load imposed on their body during the delivery and reception of blows. It is also plausible that an experienced fighter has been exposed to more dangerous techniques, and is comfortable using them during competition. Higher competitor rank has been positively correlated with higher injury incidence in karate competition.[4] Based on this, one could just as easily presume that a more skilled competitor is more likely to sustain an injury than would a novice. Our data revealed that the black belt competitors were more likely to sustain multiple injuries than their colored belt counterparts. Whereas, the colored belts were more likely to sustain single injuries compared to the black belts in our study. Lystad et al reported that level of play did not influence injury incidence.[19]

With respect to experience and location of injury, lower limb and head injuries were the most common in all groups, with no significant differences between experience groups. This is to be expected, as the head is a vulnerable location and black belt competitors seeking competition victory would choose it as a target. However, this was a surprising finding among colored belt competitors since no contact or only light contact were allowed for colored belt competition. The colored belts' lack of experience and control may have been contributing to this higher than expected rate of head injury.

When experience and injury mechanism were examined it was noted that colored belt competitors appear to suffer injury most likely while receiving a kick, possibly

due to poor defensive techniques. This may serve as a reminder to novice athletes to focus more on their defensive capabilities than their striking. Black belt competitors appeared to have a significant influence on injury due to a past history of injury to the same region. It is to be expected that injuries occur over an individual's Taekwondo career, and may influence not only match outcome but injury prevalence. Experienced competitors would be wise to learn from past experience and make sure not to overly stress areas of previous injury. Black belt competitors also trended to suffer injury while delivering a kick. Future studies should address where the elite level athlete is at greatest risk for injury which would affect their performance. In addition, further studies are recommended investigating effective injury prevention strategies. As Taekwondo emphasizes the use of the lower limb in combat, it is not surprising that all groups chose the kick as their primary defensive and offensive weapon.

When experience level and injury type were examined, all experience levels suffered similar injuries, with the top three injuries being contusion, sprain, and strain. However, it was found that colored belt competitors had significantly more contusions than black belt competitors. We speculate that this may be due to less experienced competitors attempting more aggressive, less controlled strikes, causing injury to both themselves and their opponents. The findings appear to support the hypothesis that less experienced competitors may attempt to compensate with more aggressive tactics. This also supports the WTF recommendation which requires that elite level tournament competitors should hold a minimum rank of black belt.[1] This recommendation appears to offer a measure of inherent injury prevention. Future studies should make an effort to examine if the difference noted in this study exists between each colored belt level. An additional variable to be considered is the amount of time an individual has spent in full time training, as various schools, and individuals have differing rates of rank progression. Black belt competitors appear to have suffered more joint dysfunction/irritation due to competition. Haldeman[20] defines joint dysfunction quoting Drum (1973) as, "Joint mechanics showing area disturbances of function without structural change; subtle joint dysfunctions affecting quality and range of joint motion. They are diagnosed with the aid of motion palpation, as well as stress and motion radiography investigation" [p. 623]. Greenman[21] states: "Joint dysfunction is characterized by findings of misalignment, relative fixation, loss of normal range-of-motion and end-play, tenderness, and tissue texture abnormality" [p. 13–14]¸ Kazemi and Pieter[6] also reported joint dysfunction to be the second most common injury sustained by male athletes (13.7/1,000 A-E).

The current data collection system underestimates repetitive stress injuries and their effects. Sub-categorization of the previous injury category would help to flush out repetitive injuries. Record keeping for regional, provincial and national level competition must be improved so that detailed statistics of injury incidence may be tracked over a long term basis. A viable option is to adopt a standardised classification system to be utilized by all martial arts medical teams, allowing for cross- and intersport comparisons. The Orchard Sports Injury Classification System would in part serve as a starting point,[22] but would not serve as a complete system for martial arts. Other researchers have also noticed a need for a standardized classification system for injury reporting in Taekwondo.[19,22] We believe martial art injury documentation should at least include information about the mechanism of injury. A limitation of this study was the need to remove a large number of injury reports due to missing data. Thus, some calculations were more reliable than others, as they reflected a larger percentage of the full sample of reports. This is partly a result of some competitors not providing all the necessary information and health team members not completely filling out the report. This was compounded by the presence of injured competitors who felt their injury was not severe and thus decided to terminate their visit partway through the examination. These records were not destroyed as part of record keeping protocol. A standardized protocol for injury report completion should be developed to prevent future missing data. The refinement of the standardized injury report form published by Kazemi and Pieter,[6] and used by the health teams, would also serve to benefit not only the researcher, but the injured athletes as well. New injury reports should also include such information as whether the athlete completed the match, if a stoppage was called, and in what round, as well as an injury severity ranking. Such measures will serve to further research in Taekwondo injury and to develop strategies to avoid injury and reduce time loss.

Conclusion

The results of this study show that the three most common locations of reported injury in this study were the head, foot, and thigh, respectively; these remain as areas of concern for injury prevention. Recent rule changes do not appear to increase reported head injury incidence, and thus cause no increased risk of significant injury to competitors in this cohort. Colour belt competitors are more likely to sustain injuries, particularly in the form of contusions, possibly due to more aggressive tactics and lack of control. Younger athletes (under 18) sustained more injuries than older athletes, presumably for the same reason. The vast majority of injuries were suffered by all competitors due to either receiving a kick or delivering one. This is expected in a sport focused on the use of the lower limb as a primary weapon. The data in this study spanned competitors of all ages and experience levels and thus we believe it represents the average Taekwondo participant and reflects the true risk of participation in the sport. Future studies of such injury statistics should help elucidate the athletes and body regions at highest risk of injury, and steps may be taken to prevent such injury in these individuals.

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