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Common injuries of joints and internal organs among martial arts athletes, and their classification using Delphi and DEMATEL methods

(A review of sports researches and a guide for gathering the statistics)

Abstract

In medical researches, health has always been regarded as one of the main issues. In sports, particularly martial arts, which are associated with higher rates of injuries, health is of higher significance. Accordingly, more researches and scientific reviews are required for the identification and recognition of physical injuries. Various studies have been performed on sports injuries, most of which used statistical methods and qualitative approaches. Due to the importance of the issue, a more comprehensive approach is required for the systematic and scientific identification of sports injuries of the joints and body organs of martial arts athletes. In this study, for identifying martial arts injuries, we used a managerial decision-making method based on the principles of mathematical modeling. The advantage of this method is that based on pairwise comparison and using the diagnoses of the professionals and orthopedic specialists, causes and interactions can be identified. Therefore, this method can identify the injuries affecting the organs and joints and determine their susceptibility and importance.

Keywords: Sport injuries, joints, Martial arts, Delphi method, Athletes

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Majid Shoeibi, *; Amir Reza Kachooie, MD*

* Mashhad University of Medical Sciences, Orthopedic Research Center, Mashhad, Iran

Corresponding author:
Majid Shoeibi
Email Address:
majidshoeibi@yahoo.com

Introduction

In recent years, the tendency to participate in martial arts (e.g., karate, taekwondo, and judo) has significantly increased. As throughout the world, more than 75 million people in the 10-19 years age group (i.e., adolescents) are active in at least one martial art. Nazari et al. (2012) indicated a significant relationship between the agonist muscles strength imbalance in the ankle, knee, and hip joints and the incidence of muscle injuries. Also, there was a significant relationship between the antagonist muscles' strength balance (at each joint) and the incidence of muscle injuries. Therefore, they concluded that the strength imbalance of the symmetrical muscles and antagonist muscles of the joints of the ankles, knees, and hips are among the best predicting factors of the muscle injuries of young athletes. Hence, before the tournaments, professionals should consider establishing the strength balance of the muscle groups to prevent the incidence of muscle injuries[(1)].

Mardani-Kivi et al., in a study on the knee injuries and associated factors among the athletes of Guilan province (Iran), revealed that the anterior cruciate ligament (ACL) injury was the most frequent injury of martial arts athletes. Also, its frequency among female athletes was higher. Injuries of the medial and lateral meniscus were the least frequent injuries[(2)]. Emad et al., in a study on the 30 selected athletes out of 60 kickboxer participants, observed 12 cases of ulnar nerve entrapment in the population. In 13 other athletes, tibial nerve involvement was observed.

Median nerve entrapment on the wrist was not reported in any of the athletes. The relationship between age and nerve involvement was significant, and the involvement in the 23-28 years age group was more common than the 17-22 years age group[3]. Karimi et al. studied the sports injuries of the karatekas in the international tournaments and concluded that 80% of the injuries were mild, 17.3% were moderate, and 2.7% were severe. Face and head (49.3%) were more vulnerable than other parts. Contusion (60%) was the most common form of injury, followed by bleeding (21.3%). The frequency of the injuries at the first, second, and third minutes of the match were 24%, 37.3%, and 17.3%, respectively. Also, 21.3% of the injuries occurred outside the match time. Hence, most of the karate injuries were mild, and the frequency of injuries was low. Contusion was the most frequent injury. Also, Injuries were more common during the second minute of the match. Head and face were more prone to injury[4]. Alizadeh et al. reported that the average frequency of hands, neck, and torso injuries for karate, taekwondo, and judo athletes were 57.06%, 38.27%, and 25.93%, respectively. Also, they reported that most of the head and neck injuries were related to taekwondo, but in karate and judo, most of the injuries occurred in the lower parts of the body. Injuries of taekwondo and karate included contusions and muscle sprains, while judo injuries were mostly muscle sprains followed by contusion[13].

Mahmoud Hashemi and Rajabi (2005), in a study on the jaw and facial injuries of the female martial arts athletes, indicated that among the observed injuries, mild injuries to the soft tissues were the most frequent form of injuries. They reported no dental injury. Injuries were categorized into dental, skeletal, and soft-tissue injuries. A total of 4 skeletal and 16 cases of soft tissue injuries were reported. No dental injuries were reported. Reported skeletal injuries included 11 reports of contusions and bruises, three reports of abrasion, and two cases of lacerations. A total of 12 injuries were related to karate, and four occurrences were related to taekwondo. Hence, in martial arts, the risk of jaw and facial injuries was low. Most of the observed injuries consisted of soft tissue injuries[5].

Ziaie et al. tried to determine the frequency of injuries among teenage and adolescent female Shotokan style karate athletes. They found that the 33 reported injuries (out of the 167 participants) consisted of 14 injuries related to the organs, 10 cases related to the head and neck, and 8 cases related to the torso. The frequency of the injuries was 0.17 injuries per match and 1.8 per every 10 participants[6]. Ghaffari Nezhad and Taghi Zadeh stated that the flexibility of the iliopsoas and hamstring muscles in taekwondo athletes are significantly higher; while, tensor fasciae latae piriformis muscle had higher flexibility among the footballers, and the flexibility of quadriceps and aductor magnus muscles were notably higher among the wrestlers[7].

Rahimi et al., studying the prevalence of sports injuries among the professional male karatekas of Isfahan (Iran), found that an average of 4.35 injuries occurs at every 1000 hours of matches and training sessions. Among the 185 recorded injuries, lower limbs (35%) and head and face (32%) with 64 and 60 reports, respectively, were the most common sites of injuries. About 46% of the injuries occurred at the training sessions, and 40% were related to the matches. In terms of severity, most of the injuries (43%) were mild. Technical foul of the opponent

(26%) was the primary mechanism of the injuries. Considering the type of the injury, contusions and bruises (25%) were the most frequent reports. In terms of the time of the injury during the tournaments, most of the injuries occurred before the competition season[8].

Askari et al. indicated that the uptake of quercetin supplement would have beneficial effects on the performance of the athletes. By increasing the biogenesis of muscle mitochondria, quercetin would increase VO2 max and delay sports-induced fatigue. Also, by inhibiting the NADPH-oxidase and activation of eNOS, the concentration of nitric oxide would increase, and the concentration of endothelin would decrease. Therefore, endothelial performance would be enhanced. Yet, in some of the studies, quercetin had no significant effect on the oxidative condition of the body[9]. Fattahian et al. studied the relation between the flexibility of cuff muscles and the performance of injured athletes in the ankle area. No significant relationship was reported between the flexibility of the injured cuff muscles and the total score of the questionnaire. Yet, the relationship between the flexibility of the healthy muscles and the total score of the questionnaire was significant. As a result, athletes with more flexible cuff muscles had better ankle performance. The lack of flexibility of the muscles in athletes was not necessarily associated with suboptimal performance[14].

Shabestari et al. reported that contusion, dislocation, sprain, and muscle strain were the most common injuries among the elite male kabaddi players, with frequencies as 76.2%, 59.35%, 37.41%, and 19.96%, respectively [10]. Ramezan Pour et al. found that among the athletes of the team sports, injuries of the upper body with 49.9% prevalence, and among the athletes of the individual sports, injuries of the lower body with a frequency of 44.4% were the most common injuries. About 59.2 percent of the injuries of team sports and 61.3 percent of the injuries of individual sports consisted of muscle-tendon injuries. Contusion was the most frequent form of injury, with 29.1% prevalence among the athletes of the team sports and 42.2% prevalence among the athletes of the individual sports[11]. Rahimi et al. studied the sports injuries related to karate and concluded that most injuries were mild and moderate. Therefore, despite the public belief that karate is a violent sport, parents can be assured that karate is relatively a safe sport[12].

Factors affecting the severity

In addition to the type of the injuries (including muscle or tendon strain, sprain, ligament injuries, concussion, contusion, abrasion, laceration, fracture, and hematoma), other factors such as time, mechanism, type of the movement, severity, and catastrophic injuries also affect the severity of the injuries to the joints and organs.

Time of the injury

In various studies, the time of injury was categorized as (a) injuries during the training or match and (b) injuries before the competition season, during the season, and after the season. In studies on taekwondo, most of the reported injuries were related to the match, and only limited studies reported injuries during the training[16]. In karate, numerous researchers including, Sasa[17], Kujala et al. (70%) [18], and Halabchi et al. (46%) [19], reported that most of the injuries occurred during the training, most of which occurred before the competition season. In judo, a limited number of researchers such as Souza et al. (49.1%)[20] and Buschbacher et al. (58.5%)[21]

reported injuries during the match; while numerous studies indicated that most of the injuries occur during the training, including Raschka (55.9%) [22] and Kujala et al. (70%)[18] which stated that most of the injuries happened during the training. Notably, there was no relationship between the competition season and match intervals and the prevalence of the injuries[23] .

Mechanisms of the injury

In martial arts, especially taekwondo, kicks (i.e., blows with feet) are potentially the primary cause of injuries. For example, defensive strikes and offensive strikes cause 43.9% and 34.6% of the injuries, respectively[24]. Zemper and Pieter (1998) reported kicks as the primary mechanism of injury among men and 40 percent of the injuries among women[25].

The most common mechanisms of injuries in taekwondo include opponents' strikes and striking followed by falling on the ground[26]. In karate, most of the injuries are made by kicks; open-hand strikes and lapel-grab techniques using fingers are among other mechanisms in this martial art[27]. In judo, the primary causes of injury include standing, throwing, and ground techniques; yet, the foul of the opponent is the primary mechanism of injuries in judo [23].

Moves leading to injuries

In a nine-year report about taekwondo, it was revealed that defensive kicks offensive kicks are the causes of injuries in 44% and 35% of the cases, respectively [24]. In karate, kicks are related to the prevalence of injuries. In one study on karate, 67% of the hematoma cases occurred at the time of stop or taking the hits (especially during training), and 87.5% of the sprains occurred while defending the strikes [27]. It is clear that in judo, standing techniques such as Tachi-Waza and throwing techniques are the second most damaging techniques; following the Tachi-Waza and Seoi-Nage techniques, 72.2% and 28.4% of the injuries occurred, respectively [20, 28, 29].

The severity of the injury

In international tournaments, mild and severe injuries constitute 80 and 2.66 percent of the injuries, respectively. In studies on taekwondo, most of the reported injuries were mild [16]. Researchers described 68.7 to 89.3 percent of the karatekas injuries as "mild" injuries. Also, in judo, the number of serious injuries was limited [23].

Catastrophic injuries

According to National Center for Catastrophic Sport Injury Research (NCCSIR), a catastrophic injury is defined as any form of sports injury resulting in the brain or spinal cord damage, broken spinal cord, or fracture of the cranium. Catastrophic injuries are divided into three classes: (a) fatal injuries, (b) non-fatal injuries, and (c) serious injuries[30]. Recently, the most frequent injury reported among male taekwondo athletes with a black belt during the matches was concussion[24]. Also, there were reports of catastrophic injuries indicating that spinning kicks of experts to the celiac network of athletes (athletes not wearing protective covers) had resulted in vagal stimulation and cardiac arrest. Kicking with the back of the foot (while spinning) to the lower left part of the chest resulted in aspiration, asphyxia, and death [16].

Halabchi et al. studied the Iranian female karatekas and reported a rate of 13.7% passing out by kicks. They believed that the cause was that coaches instructed severe blows to the head for gaining more scores, to the extent that sometimes the

strikes cause them to fall and hit their head to the ground [19].

Data and statistical analysis

We used field studies and online searches in related international scientific websites for data collection. Also, to evaluate and confirm the data validity, the Delphi method in the form of pairwise comparison questionnaires and interviews with orthopedic specialists and physicians was employed. The related resources to the subject were reviewed, orthopedic specialists were interviewed, and considering the previous studies, the criteria for selecting the strategies were identified and reviewed. Therefore, a questionnaire was designed and distributed. The calculated consistency ratio was less than 0.1, which justified the sample size. Considering that the questions were based on the Likert scale to evaluate the interaction between the criteria, the assigned score to each question ranged from 0 (i.e., the lowest effect) to 5 (i.e., the highest effect). Accordingly, the average score of each question was within the same range.

After three stages of sending and receiving the questionnaires, the opinion of the experts became convergent. Criteria that scored higher than the average were approved. Then, using the obtained data from the questionnaires, the primary matrix for a direct relationship using the DEMATEL method was formed. Seven criteria were selected to evaluate the susceptibility and prioritize the strategies of knowledge management in the organization. Since the input of the DEMATEL technique (the primary matrix for direct relation) was determined, using an Excel datasheet, based on the DEMATEL solving steps, we calculated the normalized matrix of direct-relation. Eventually, we formed the matrix for total relation, and considering the obtained diagram from the output of the DEMATEL method, we determined the susceptibility and impact of the criteria.

Delphi Method

In this method, the opinion of the experts and specialists would be collected multiple times through questionnaires and sent back. The critical issue is that the participants must state their point of view without being affected by the famous and skilled orators. In this method, by removing the effect of skilled orators, every opinion and belief can be collected and sent back to the participants after being analyzed. Thus, anonymity and receiving feedbacks are the two essential elements of the Delphi method [31]. The purpose of this method is to determine the most important decision-making criteria.

DEMATEL method

DEMATEL is one of the multicriteria decision-making methods based on pairwise comparisons. DEMATEL method was based on the graph theory and proposed by E. Fontel and A. Gabul in 1971, and using the judgment of the experts (by finding the factors) provides us with the solution to the problem. To understand the present relations, we can draw the network-relationship map for various criteria related to the cause-effect [33, 34, 35, 36]. The intensity of the effects of the mentioned relations is determined by scores. Since directed diagrams are better indicators of the relationship between the elements of a system, this method is based on graphs that can separate the involved parameters into causes and effects. Henceforth, their relationship is presented as an understandable structural model [32].

By investigating table 1, the research model, and the causal diagram, we can understand which of the 14 introduced factors influence the matter or are susceptible to the problem. The factors placed over the horizontal axis of the

chart (the positive area) influence the matter. Factors 10 and 7 have the highest scores; subsequently have the highest level of influence on identifying the effects of sports injuries (i.e., martial arts) on organs and joints. Also, factors 3 and 13 located under the horizontal axis (the negative area) are the affected factors and have the lowest scores (negative weight). In other words, in comparison to others, these factors are less important to determine the sports injuries of martial arts on the joints and organs of the athletes. Also, it is worth mentioning that other factors are ranked, and details about their influence on the subject of the study are presented (table 1).

Table 1. Ranking of the causes of injuries.

Rank	Priority	Importance, based on the weight of the diagnoses
1	Factor 10	Exercise-induced fatigue can increase the vulnerability of the joints.
2	Factor 7	Due to the higher number of impacts in martial arts, iliopsoas and hamstring muscles are more flexible.
3	Factor 2	Injuries of the lateral meniscus are common among male martial arts athletes.
4	Factor 1	In comparison to male athletes, anterior cruciate ligament (ACL) injury is more common among female martial arts athletes.
5	Factor 9	The vulnerability of the organs increases before the start of martial arts tournaments.
6	Factor 14	As martial arts are among the individual sports, it plays a role in the severity of the injury.
7	Factor 5	Among skeletal injuries, dislocation is more frequent than fracture.
8	Factor 8	Most of the injuries of organs and joints occur while martial arts athletes are training.
9	Factor 6	In martial arts athletes, the upper parts of the body are more prone to injuries.
10	Factor 3	Muscle contusion is the most frequent form of injury among martial arts athletes.
11	Factor 12	The more flexible the leg's muscles are, the function of the athlete's ankles (martial arts) would be better.
12	Factor 11	The oral uptake of quercetin supplements would improve the athletic performance of martial arts athletes by delaying fatigue.
13	Factor 4	Muscle sprain in the head and neck is not frequent among martial arts athletes.
14	Factor 13	Reduction of the flexibility of the leg muscles Increases the likelihood of ankle sprains.

Conclusion

Based on the obtained data from the model analysis using the Delphi and DEMATEL methods, it can be concluded that sports-induced fatigue and increase in the flexibility of iliopsoas and hamstring muscles are among the factors that contribute the most to the vulnerability of the joints and organs of the martial arts athletes. Also, the decrease in the flexibility of the calf muscles (which results in the higher risk of sprain in the ankles) has the lowest effect on the vulnerability of the joints and organs of martial arts athletes. We identified the sports injuries on joints and organs of martial arts athletes. However, the suggested model can be used to study other variables and target groups. Considering the comprehensiveness of this study in identifying the damaging factors and prioritizing these factors, orthopedic specialists and physicians can employ the findings of the study.

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