

Analysis of injuries in Judo athletes: A systematic review

Análisis de lesiones en deportistas de judo: revisión sistemática

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Abstract. This article aimed to identify general characteristics, etiology, and location of injuries in Judo athletes. A systematic literature search was carried out up to July 2020 on the databases MEDLINE (via PubMed), LILACS (via BVS), and Science Direct to find studies that focused on the type, location, and causes of injuries in Judo athletes of both sexes and older than 18 years old. The following data were extracted from the studies: author/year, study country, sample size, competition level, injury type, location, and context of the injury. The methodological quality of the included studies was assessed by the Critical Appraisal Skills Programme (CASP) tool. A total of 725 studies were retrieved from the databases and 12 were selected. The selected studies involved athletes from national and international levels. The situation of training and competition was the most cited context of injury. Considering injury etiology, the location was generalized in most of the studies and the more frequent injury types were: sprains, strains, dislocations, and fractures. In relation to severity, head and neck injuries were described in 66% of the studies. Our results suggest higher awareness related to technical learning strategies to Judo practitioners that is independent of skill level. Since injury etiology is a multifaceted process, increased efforts must be invested to lower or avoid more severe injuries that are more prone to produce negative outcomes like death or disabilities.

Keywords: Judo, Epidemiology, Prevention, Martial Arts, Sports, Athletes, Athletic Injuries, Musculoskeletal System.

Resumen. El objeto de este estudio consiste en identificar las características generales, etiología y ubicación de las lesiones en los deportistas de Judo. Se llevó a cabo una búsqueda bibliográfica sistemática hasta julio de 2020 en las bases de datos MEDLINE (a través de PubMed), LILACS (a través de BVS) y Science Direct para encontrar estudios que se centraran en el tipo, la ubicación y las causas de las lesiones en los atletas de Judo de ambos sexos y sexos mayores de 18 años. Se extrajeron los siguientes datos de los estudios: autor/año, país del estudio, tamaño de la muestra, nivel de competencia, tipo de lesión, ubicación y contexto de la lesión. La calidad metodológica de los estudios incluidos se evaluó mediante la herramienta *Critical Appraisal Skills Program* (CASP). Se recuperaron un total de 725 estudios de las bases de datos y se seleccionaron 12. Los estudios seleccionados involucraron a deportistas de nivel nacional e internacional. La situación de entrenamiento y competición fue el contexto de lesión más citado. Teniendo en cuenta la etiología de la lesión, la ubicación fue generalizada en la mayoría de los estudios y los tipos de lesión más frecuentes fueron: esguinces, distensiones, luxaciones y fracturas. En relación con la gravedad, las lesiones de cabeza y cuello se describieron en el 66% de los estudios. Nuestros resultados sugieren una mayor conciencia relacionada con las estrategias de aprendizaje técnico para los practicantes de Judo que es independiente del nivel de habilidad. Dado que la etiología de las lesiones es un proceso multifacético, se deben invertir mayores esfuerzos para reducir o evitar lesiones más graves que son más propensas a producir resultados negativos como muerte o discapacidades.

Palabras clave: Judo, Epidemiología, Prevención, Artes Marciales, Deportes, Atletas, Traumatismos en Atletas, Sistema Musculoquelético.

Introduction

Judo was created in 1882 by Jigoro Kano. This martial art came from Ju Jutsu and is among one of the most practiced sports in the world. Judo is a physical and mental discipline (guided by the desires of the theme, history, principles, ideologies, and philosophy of life). Its fundamental principle is that, whatever the objective is, it

will be more easily achieved through the maximum use of efficiency, mind, and body. This principle, applied in the practitioner daily lives, leads to a better and more rational life (Kano, 2008).

According to the International Judo Federation, Judo is practiced by more than 20 million athletes worldwide, represented by more than 200 countries (Pococco et al., 2013). The advance in Judo practice has been gaining prominence in general. In a survey carried out in Japan, the number of adults doing sports at least once a week was 47.5% (Mizobuchi & Nagahiro, 2016). At the London 2012 Olympic Games, 383 athletes from 135

countries participated in the Games, which made Judo one of the three most popular sports of the Games (Frey et al., 2019).

Well planned training sessions have a favorable impact on the health and performance of its practitioners. The benefits of regular exercise have been known for a long time. However, in athletes, this balance is often weakened due to the relationship between training and competition periods with rest intervals, which, when insufficient, can lead to the appearance of a condition called overtraining or overtraining syndrome. Judo training consists of dynamic and intermittent efforts, with high metabolic and hormonal demands (Degoutte et al., 2003; Koury et al., 2007; Casimiro-Lopes et al., 2009).

However, the technical quality and excellence of high-level Judo require constancy, time, training, practice, adequate physical condition, and dedication. The height and strength of the Judo blows can be highly damaging to the opponent's physical integrity (Tola et al., 2020). In this sense, one of the consequences of the performance search that most disturb top athletes are injuries. Such events can be caused by illness, trauma, or simply by playing sports, for example. Injuries from sports practice are quite common in the environment, causing discomfort and concern in athletes, coaches, and even in the managers. In addition to causing negative effects on the physical and emotional damage to the athletes, injuries cause financial loss to clubs and create difficulties for coaches in their training plans (Amorin et al., 1989).

The term injury can be described as a musculoskeletal symptom that causes an athlete to stop training or competing for more than 24 hours (Timpka et al., 2015). Regarding the type of injury (acute or chronic), they are the result of complex interactions between risk factors. Sports injuries can be caused by several factors, which in combination can result in the appearance of an injury. Therefore, a multidimensional approach can be more effective in the search for prevention (Ross et al., 2021).

According to Meneses (1983), the lesions can be classified as typical and atypical. Typical injuries are those directly associated with sports practices, that is, those with the highest incidence in sports, which affect more significantly than the atypical ones, occurring both in the training phase and in the competition phase. On the other hand, atypical injuries are those occasional (uncommon) to sports, that occur by accident.

The lack of epidemiological data regarding Judo in-

juries was partially addressed in the study of Pocco et al (2013). Nonetheless, there is still little systematic information related to injuries in Judo practitioners as a whole. In this case, we chose to analyze adult competitive practitioners from different skill levels. Therefore, this study aimed to identify general characteristics, etiology, and location of injuries in Judo athletes over 18 years old of both sexes.

Methods

The present study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria (Galvão, Pansani, & Harrad, 2015).

Eligibility criteria

We included epidemiological studies whose outcome was the musculoskeletal injuries resulting from the time of exposure to training or competitions on Judo athletes over 18 years old of both sexes. Review articles, case studies, biomechanical studies, surgical studies, publications from conferences and congresses were excluded. Furthermore, we excluded studies written in a language other than English, Portuguese, or Spanish.

Search strategy

A systematic search without language or time filters was performed in three databases (MEDLINE/PubMed, LILACS/BVS, and ScienceDirect) with the last update on July 2020. We used the following search phrase: ((injury [Title/Abstract]) OR (injuries [Title/Abstract])) AND (judo [Title/Abstract]). All references tracked by the search were exported to a shared Endnote library. Two independent authors performed the search, exclusion of duplicates, inspection of titles and abstracts, and screening of the full texts. Any disagreement during the analysis was sent to another author for consensus. Then, the full version of the studies was analyzed and we excluded those that did not meet the inclusion criteria.

Methodological quality

The methodological quality of the studies included in this systematic review was assessed by the Critical Appraisal Skills Programme (CASP) tool, available at: <http://www.casp-uk.net/casp-tools-checklists>. This tool aims to analyze possible quality problems and methodological biases in each research. The CASP is composed of 12 domains for clarifying the levels that must be answered with «yes», «no», and «I cannot say»,

totaling a final score that can be classified as: high quality (10 to 12), moderate quality (7 to 9), and low quality (0 to 6), as recommended by Smith et al. (2018). Each domain has its objective and criteria for a result. Two evaluators were responsible for addressing conflicts of interest that could impair the quality of the studies and a third evaluator was required to resolve any disagreement during the evaluation.

Data extraction

To characterize the sample, data on nationality, age, sex, and sample size were extracted. For the extraction of results, data on the frequency of the lesion and the anatomical region where the lesion occurred were extracted.

Results

A total of 725 studies were retrieved from the databases. After using the eligibility criteria, 12 studies were included in the systematic review (Figure 1).

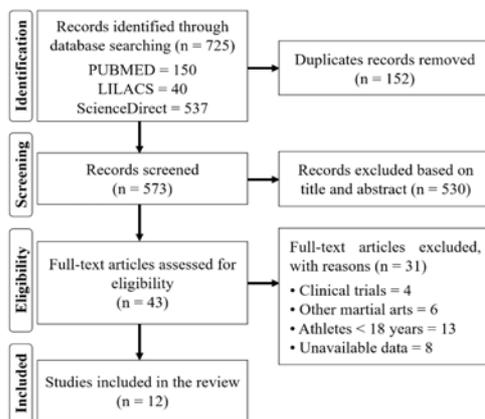


Figure 1. PRISMA flowchart.

Table 1 presents the descriptive characteristics of the studies included in the present review. Most of the selected studies involved athletes from national and

Table 1

Characterization of the included studies.

Authors, year	Study origin	Sample size	Competition level
Nakazawa et al., 2020	Japan	75	National
Souza et al., 2006	Brazil	93	State
Manzato et al., 2017	Brazil	111	State
Kim et al., 2015	Korea	144	National
Kamitani et al., 2013	Japan	10	National/International
Green et al., 2007	UK	392	National
Frey et al., 2019	France	316,203	National/International
Frey et al., 2004	France	56,059	National/International
Carazzato et al., 1996	Brazil	129	National/International
Akoto et al., 2018	France	4,659	National/International
Alizai et al., 2019	USA	390	Olympic
Barsottini et al., 2006	Brazil	46	National

international level and the majority of publications came from Brazil (4 studies), France (3 studies), and Japan (2 studies). Korea, USA, and UK contributed equally with one study each. Half of the studies were published in the last five years.

Table 2

Data extraction related with injury type, location, and context of occurrence.

Study	Injury type	Location	Context
Nakazawa et al., 2020	Sprain, fractures, dislocation, pain, others	Shoulder, ankle, knee, forearm, low back, elbow, toe, others	Throwing, grappling, fall down, collision, others
Souza et al., 2006	Sprain, contusion, strain, ligament injury, partial dislocation, total dislocation, meniscus injury, fracture, incision, tendon rupture	Shoulder, arms, hands/ fingers, column, thighs, knees, ankle, feet, rib, others	Training, competition, physical conditioning, others
Manzato et al., 2017	Myotendinous, articular, bone	Head, legs, trunk, arms	Training, accident, physical conditioning
Kim et al., 2015	N/A	Cervical spine, shoulder, arms, elbow, forearm, wrists, hand, finger, ribs, upper/lower back, pelvis, hip, thigh, knee, ankle, foot	Training, competition, physical conditioning
Kamitani et al., 2013	Acute subdural hematoma, cerebral contusion, subarachnoid hemorrhage	Head/neck	Training
Green et al., 2007	Cut, bruising, burn, fracture, sprain, strain, other	Head/neck, shoulders, fingers, elbow, trunk, knee, ankle, foot	Training
Frey et al., 2019	Muscle injury, sprain, fracture, dislocation, concussions	Head/neck, trunk, low back, glenoid, meniscus, wrist, elbow, foot	Competition
Frey et al., 2004	Sprain, fracture, luxation	Head/neck, trunk, upper/lower limb, column, elbow, foot	Training, competition, physical conditioning
Carazzato et al., 1996	Sprain, contusion, strain, ligament injury, partial dislocation, total dislocation, meniscus injury, fracture, incision, tendon rupture	Cervical spine, shoulder, arms, elbow, forearm, wrists, hand, finger, ribs, upper/lower back, pelvis, hip, thigh, knee, ankle, foot	Training, competition, physical conditioning
Akoto et al., 2018	Muscle injury, sprain, fracture, dislocation, concussions	Head/neck, trunk, low back, glenoid, meniscus, wrist, elbow, foot	Training, competition, physical conditioning
Alizai et al., 2019	Tendon and ligament injury	Upper limbs	Competition
Barsottini et al., 2006	Sprain, contusion, strain, ligament injury, partial dislocation, total dislocation, meniscus injury, fracture, tendon rupture	Shoulder, arms, hands/fingers, column, thighs, knees, ankle, feet, rib, others	Training

Legend: N/A= not applicable.

Table 2 shows injury type, location, and context of occurrence. The situation of both training and competition was the most cited context. Considering injury etiology, the location was generalized in most studies and the more frequent injury types were: sprains, strains, dislocations, and fractures. In relation to severity, head/neck injuries were described in 66% (8 out of 12) of studies.

Table 3 presents the methodological quality of the included studies analyzed through the CASP tool. The selected studies showed moderate to high methodological quality when evaluated by the CASP tool. However, 83% of studies (10 out of 12) presented «no» as the answer to question number 8 that is related to data analysis rigor.

Table 3

Methodological quality of the selected studies using the CASP tool.

Studies	1	2	3	4	5a	5b	6a	6b	7	8	9	10	11	12	Score
Akoto et al., 2018	Y	Y	Y	CT	Y	Y	NI	NI	Y	N	Y	N	Y	Y	8
Alizai et al., 2019	Y	Y	Y	Y	Y	Y	NI	NI	Y	N	Y	Y	Y	Y	10
Barsottini et al., 2006	Y	N	N	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	8
Carazzato et al., 1996	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	9
Frey et al., 2004	Y	Y	Y	CT	CT	CT	Y	Y	Y	N	Y	N	CT	Y	7
Frey et al., 2019	Y	Y	Y	CT	CT	Y	Y	Y	N	Y	N	Y	Y	Y	9
Green et al., 2007	Y	Y	Y	Y	N	N	Y	Y	Y	N	Y	Y	Y	Y	10
Kamitani et al., 2013	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	11
Kim et al., 2015	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	11
Manzato et al., 2017	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	12
Nakazawa et al., 2020	Y	NI	Y	Y	N	N	Y	Y	Y	N	Y	Y	N	Y	8
Souza et al., 2006	Y	Y	Y	Y	N	N	N	Y	Y	N	Y	Y	Y	Y	10

Legend: 1- Did the study address a clearly focused issue?; 2- Was the cohort recruited in an acceptable way?; 3- Was the exposure accurately measured to minimize bias?; 4- Was the outcome accurately measured to minimize bias?; 5a- Have the authors identified all important confounding factors?; 5b- Have they taken into account the confounding factors in the design and/or analysis?; 6a- Was the follow up of subjects complete enough?; 6b- Was the follow up of subjects long enough?; 7- What are the results of this study?; 8- How precise are the results?; 9- Do you believe the results?; 10- Can the results be applied to the local population?; 11- Do the results of this study fit with other available evidence?; 12- What are the implications of this study for practice?; Y= yes; N= no; CT= cannot tell; NI= not informed.

Discussion

The present systematic review aimed to identify general characteristics, etiology, and location of injuries in Judo athletes. The main findings of this study described generalized injury sites from broad etiologies, with athletes suffering from injuries both in training and in competition situations. The most frequent injury types were sprains, strains, dislocations, and fractures. Moreover, head and neck were the most common location of injuries among the included studies.

Additionally, the competition level ranged from national to international, including Olympic athletes. Some possibilities could be raised to explain the occurrence of injuries even among high-level Judo athletes since increased training loads together with decreased rest periods can be a relevant factor (Kreher & Schwartz, 2012). Besides, aggressive weight loss protocols could also play a role (Rico et al., 2018).

Mizobuchi and Nagahiro (2016) observed that, regarding death or severe disability during physical activities, Judo surpasses other contact sports normally described as high-injury risk activities like rugby and boxing. The mechanisms involved in these outcomes seem to be related to rotational acceleration during falls that produce increased forces inside brain structures leading to major trauma.

Judo throws were created to allow practitioners to fall safely in the mat as a strategy to avoid the risk of injury (i.e.: ukemi). However, some of these techniques can impair protective mechanisms. In this regard, Osotogari and Uchi-mata present higher requirements of biomechanical skills making safe falls more difficult to be performed (Kamitani et al., 2013).

Bearing in mind that the type of injury is directly associated with the specificity of the sport, as well as with some factors that can be controlled by the athletes themselves, by their coaches or, in most cases, by both, and knowing that Judo is a contact sport, we can suggest that Judo athletes are more prone to injuries (Santos et al., 2001). However, according to Cruz (1997), in the Judo competitions held in Portugal, the incidence of injuries showed a low level of severity during the competitive period. On the other hand, studies such as Lima et al. (1998) and Lima and Nogueira (1998) identified injuries in Judo athletes during some competitions and highlighted that the injuries also occurred in novice Judo athletes (i.e.: between one and/ or two years of Judo practice).

In this context, unlike other sports where injuries

do not occur due to trauma caused by direct physical contact or falls, the adoption of a complete exercise program to prevent injuries would be of lesser value (Cabeza-Carmona et al., 2019). However, there is a direct relationship between the number of seasonality and the onset of lesions, a factor that can be monitored and modulated seeking a better outcome (Román et al., 2020; Sinovas et al., 2020).

Some studies have correlated the highest incidence of injuries, such as Nakazawa et al. (2020), who studied young Judo practitioners affiliated to a club in Mongolia. It was observed that 39% of current and 25% of past Judo-related injuries. In the study, the most frequent injuries were sprains, followed by fractures, with a higher incidence in the shoulders, followed by the knee and ankle. Another study that verified the incidence of injuries in Judo was the study by Oliveira and Pereira (2008), which analyzed 30 affiliated Judo athletes in Brazil. The study found that 91% of the athletes reported some type of injury during the practice of Judo, thus confirming the high incidence of injuries. The joint with the highest incidence of injuries was the shoulder with 36%, followed by the knees and hands, with 32% each. Among the most frequent injuries, contusion stood out with 26%, followed by sprains and muscle injuries with 17% each, fractures (16%), tendinitis (14%), and dislocations (9%), ratifying the high incidence of injuries in Judo practitioners.

The study by Maciejewski and Callanta (2016) analyzed 192 Judo athletes from the Philippines. The authors found that Judo is a relatively safe activity for young adults and children because, according to the study, training variables, such as frequency and duration, did not influence the occurrence of injuries.

In another study, Barsottini et al. (2006) investigated athletes from different Judo teams in Brazil. The authors separated the injuries into mild, moderate, and severe. Mild injuries did not force training and/ or competition interruption. On the other hand, moderate injuries lead to training/ competition cessation. Additionally, withdrawal from at least one training session and/ or competition occurred for injuries classified as severe. The study concluded that, concerning the severity of the injuries, 10% were classified as mild, 9% as moderate, and 64% of the injuries were considered severe. The study also grouped the data in relation to training and competition situations. During training, minor injuries accounted for 8%, moderate injuries for 9%, and severe injuries for 54%. During competitions, mild injuries were 5%, moderate 2%, and severe inju-

ries 22%.

Regarding the severity of injuries, of the 12 articles analyzed in this study, 66% of them mentioned head/neck injuries. Despite not mentioning the type of injury, this information drew attention. Although some articles report safety in the practice of Judo (Maciejewski & Callanta, 2016; Cruz, 1997), even with the existence of minor injuries, many studies have reported the incidence of acute subdural hematoma (ASDH) in Judo practitioners, schoolchildren, and with a high mortality rate (Koiwai, 1981; Koshida et al., 2016; Mizobuchi & Nagahiro, 2016; Murayama et al., 2013; Murayama et al., 2014; Shingu et al., 1994; Uchida, 2011; Yokota & Ida, 2016). As a highlight, we can mention Kamitani, 2013 who in his study reviewed this type of injury and found that, among the studies analyzed, one of them (Nagahiro, 2011) reported 30 cases of ASDH, where 15 of them died, 5 were in vegetative state, 6 required assistance due to hemiplegia and only 4 cases showed full recovery. Also noteworthy is the study by Nambu and Noji (2014) who analyzed 118 fatal accidents, and 24 cases where practitioners remained in a vegetative state and/or paraplegia, all of them in Japanese schools.

Mizobuchi and Nagahiro (2016) observed that regarding death or severe disability during physical activities, Judo outperforms other contact sports usually described as high-risk activities for injuries, such as rugby and boxing. Some studies have analyzed possible causes for this type of injury, such as the study by Mizobuchi and Nagahiro (2016), where the authors mention that the mechanisms involved in these outcomes seem to be related to rotational acceleration during falls, which produce increased forces within brain structures leading to major trauma. Other studies suggest that the biomechanics of some techniques may favor this type of injury, such as Kamitani et al. (2013) and Gutiérrez-Santiago et al. (2012).

The fact that the acute subdural hematoma lesion (ASDH) is more common in schoolchildren, and, as it has a high fatality rate, goes against the determinations, which have been adopted in Brazil, regarding the mandatory nature of the modalities of struggles in schools. A very large number of laws (at the federal, state and municipal levels) have already been enacted with the objective of implementing the mandatory teaching of Martial Arts (modalities such as Judo, Jiu Jitsu and Capoeira) in Basic, Elementary and Medium, like educational tools.

Greater attention should be given to this process, with more awareness related to learning techniques

strategies for all Judo practitioners, especially at school age, regardless of the time of practice, in order to establish safety and prevention regulations accidents.

The limitations of the present review were limited to the low number and great diversity of studies that met the inclusion criteria. The small number of injuries analyzed was also a limiting factor. Most studies presented some threats to external validity, mainly related to data analysis rigor. Regarding acute subdural hematoma (ASDH), although MEDLINE, LILACS, and the ScienceDirect index offer a large number of scientific journals worldwide, some articles published in other journals that address this subject may not have been included in this review, due to the inclusion and eligibility criteria.

Conclusion

The present systematic review showed that injuries occurred in both training and competition circumstances. Sprains, strains, dislocations, and fractures were the most frequent injury types. Furthermore, the most cited location of injuries was head and neck. Our results suggest higher awareness related to technical learning strategies to Judo practitioners that is independent of skill level. Since injury etiology is a multifaceted process, increased efforts must be invested to lower or avoid more severe injuries that are more prone to produce negative outcomes like death or disabilities. Since, some specific technical aspects can impair Judo practitioners from falling safely, future research should focus on biomechanical aspects of Judo throwing techniques coupled with motor control and methodological learning strategies to minimize major injury risk during training and competition.

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