Injuries in judo: a systematic literature review including suggestions for prevention

Elena Pocecco,1 Gerhard Ruedl,1 Nemanja Stankovic,2 Stanislaw Sterkowicz,3 Fabrizio Boscolo Del Vecchio,4,5 Carlos Gutiérrez-García,6 Romain Rousseau,7,8 Mirjam Wolf,1 Martin Kopp,1 Bianca Miarka,5 Verena Menz,1 Philipp Krüssmann,1 Michel Calmet,9 Nikolaos Malliaropoulos,10,11 Martin Burtscher1

ABSTRACT

Background There is limited knowledge on epidemiological injury data in judo.

Objective To systematically review scientific literature on the frequency and characteristics of injuries in judo.

Methods The available literature up to June 2013 was searched for prospective as well as retrospective studies on injuries in judo. Data extraction and presentation focused on the incidence rate, injury risk, types, location and causes of injuries.

Results During the Olympic Games in 2008 and 2012, an average injury risk of about 11–12% has been observed. Sprains, strains and contusions, usually of the knee, shoulder and fingers, were the most frequently reported injuries, whereas being thrown was the most common injury mechanism. Severe injuries were quite rare and usually affected the brain and spine, whereas chronic injuries typically affected the finger joints, lower back and ears. The most common types of injuries in young judo athletes were contusions/abrasions, fractures and sprains/strains. Sex-differences data on judo injuries were mostly inconsistent. Some studies suggested a relationship between nutrition, hydration and/or weight cycling and judo injuries. Also, psychological factors may increase the risk of judo injuries.

Conclusions The present review provides the latest knowledge on the frequency and characteristics of injuries in judo. Comprehensive knowledge about the risk of injury during sport activity and related risk factors represents an essential basis to develop effective strategies for injury prevention. Thus, the introduction of an ongoing injury surveillance system in judo is of utmost importance.

INTRODUCTION

Judo is a martial art and an Olympic sport comprising standing and ground fighting.1 2 It entered the Olympic Programme for men in 1964 as a demonstration sport and officially in 1972 for men and in 1992 for women.3 During competitions, contestants are divided by sex, sometimes by grade or judo experience, and organised in age classes and weight divisions.4 Nowadays, judo ranks among the most popular Asian martial arts in the world.5 The International Judo Federation comprises more than 200 affiliated countries spread over all five continents, counting an estimated 20 million individuals.6 Considering such a high participation rate in a combat sport and the suggested relatively high injury risk,7 the safety of practitioners is of the highest priority. Therefore, research on judo injuries would be essential in identifying risk factors and suggesting potentially preventive strategies.

To protect the health of its athletes, the International Olympic Committee initiated and developed the injury and illness surveillance system during the 2008 Beijing and 2012 London Olympics.8 9 With this systematic injury registration, the most common and severe injuries, for example, in judo athletes, are identified to ensure new knowledge on injury trends over time, to form the basis for further research on injury risk factors and mechanisms, and finally to develop injury prevention programmes.10 However, the collection of epidemiological data is just the first step in the direction of injury prevention, which should be followed by more deepening studies on judo peculiarities.

In the literature, a few prospective and retrospective studies as well as case reports dealing with judo injuries are available.11–13 However, to our knowledge, no systematic overview on this important topic is available. Therefore, the aim of this paper was to perform a systematic review of injuries sustained by judo athletes.

METHODS

Literature search: A comprehensive search of the literature was performed electronically in different databases from their inception up to June 2013. The use of the Medical Subject Headings (MeSH) terms ‘martial arts’ and ‘judo’ and ‘injuries’ produced 40 publications from PubMed/Medline. Twelve of these were deemed relevant to the present work because of the useful information on judo injuries. Further searches using the same terms were carried out in the ISI Web of Knowledge, Scopus and The Cochrane Library, and injury reports from recent Olympic Games have been investigated. Of 61 publications, 13 were found to be relevant for the present review. The exclusion criteria adopted for all search strategies were cases or case series reports dealing with less than eight participants or Japanese language. Furthermore, two book chapters on judo comprising injury data have been included. Finally, to complement the present review, selected references cited in the aforementioned literature have been considered in the case of limited information on specific topics.

Definitions of injury

According to MeSH, injuries are primarily defined as damage inflicted on the body as the direct or
indirect result of an external force, with or without disruption of structural continuity. However, as a result of different designs of the reviewed literature, including prospective, as well as retrospective studies, it was not possible to adopt a standardised definition, neither of injury, nor of the severity grade of injuries. During the Summer Olympic Games (SOG), an injury was defined when an athlete received medical attention for a newly incurred injury or re-injury after full participation following the previous injury, including in-competition as well as training injuries during the SOG. Similarly, Green et al defined an injury as a situation in which the judoka either requested medical treatment or was unable to continue a contest. On the other hand, James and Pieter indicated an injury as any circumstance for which assistance was sought from the medical personnel, including time-loss injuries, which kept the athlete from completing the actual bout and/or subsequent bouts and from participating in judo for a minimum of 1 day thereafter. Regarding retrospective studies, an injury was defined as any physical complaint sustained by a competitor irrespective of the need for medical attention or time-loss from activities, or which caused an exclusion from sports-related activities for at least 4 days.

Presentation of data

Data extraction and presentation focused on the frequency, types, location and causes of injuries. Judo injuries were expressed as absolute as well as relative frequencies. The number of injured athletes divided by the number of athletes at risk is used as an estimator of the average injury risk. The incidence rate is the number of injuries divided by the number of athlete-exposures, for example, the number of fights, and is based on the epidemiological concept of person-time at risk. It has to be noted that comparisons can only be made between data using the same denominator.

RESULTS

Frequency of injuries

Online supplementary table S1 presents data on the injury risk and incidence rate in judo practice reported in the available literature.

The most recent injury data from the 2008 SOG in Beijing and 2012 in London revealed an average injury risk of 11.2–12.3% for the more than 380 participating judo athletes per SOG. Also, James and Pieter and Green et al found that 13–14% of the athletes studied sustained an injury while other studies showed clearly higher injury risks of 23–29%. The highest value was identified by Souza et al with an incidence rate of 1.18 injuries/athlete-year. The differences might be due to the different skill levels of participating athletes, involved age groups, study designs as well as injury definitions.

With regard to the potential sex differences, the reported findings were inconsistent. Some studies found no sex difference, while other studies showed a higher injury risk among men and women, respectively. Again, these differences might be due in part to different skill levels and age groups.

The importance of age as a risk factor is also uncertain, especially as it may interact with experience as a causal factor. Recent studies on elite judokas reported a higher injury risk (49–88%) during competition compared with training. In contrast, other authors showed an about 70% higher injury risk during training compared with competition, particularly in women (94%; see online supplementary tables S1–S3). An unequal proportion of time spent in training and competition during the different studies could have led to the discrepancies in the results, which may even have been influenced by memory bias.

Frey et al reported a higher frequency of injuries during lower level competitions compared with higher level ones. Moreover, competitions with a high difference in the performance level of the contestants showed a higher frequency of injuries.

Injury types

The distribution of injury types seems to be strongly influenced by the study design (see online supplementary tables S2 and S3). Regardless of the study design and sex, the most frequent injuries were sprains (5.6–59.8%), strains (7–33.8%) and contusions (5.6–56%; see online supplementary tables S2 and S3). The frequency of fractures demonstrated in retrospective studies based on institutional documentation (RD) and in prospective studies was considerably higher than in retrospective studies utilising questionnaires (RQ) and in prospective studies. Prospective studies recorded a higher variety in the classification of sustained injuries, but the percentage of serious injuries was lower when compared with RD studies.

Besides a somewhat higher percentage of sprains among female judo athletes and of strains among male judo athletes, no relevant differences have been shown between sexes (see online supplementary tables S2 and S3).

In adult as well as top-class competitors, dislocations and sprains prevailed, whereas in younger as well as lower ranked judokas upper body fractures were more frequent.

Injury location

Judo injuries mostly affect body extremities, especially the knee (up to 28%), shoulder (up to 22%) and hand/fingers (up to 30%), as shown in online supplementary table S4. Depending on the definition of injury used, fingers were sometimes indicated as the most common injury locations during competition as a consequence of grip fighting, which indeed has the biggest time share during the fight. However, these injuries were usually classified as ‘soft’. On the other hand, RQ studies identified the knee and shoulder as the most frequent injury locations as a consequence of throwing or being thrown.

No difference in the localisation of injuries has been reported between male and female judokas.

In children, the shoulder/upper arm (19%), foot/ankle (16%) and elbow/lower arm (15%) were the most common injury locations.

Injury causes

Data on injury causes in judo are presented in online supplementary table S5. Nearly 85% of judo injuries occurred during standing fight compared with ground fight, probably because more time is spent in standing fight, where athletes must grip their opponent before attacking. Indeed, as already presented, grip fighting constitutes a cause of injury to hands and fingers. Being thrown seems to be the most frequent situation leading to judo injuries, comprising about 70% (range 42–90%) of cases, including also a few severe and catastrophic injuries (see online supplementary table S5). Additionally, it was indicated that the lack in falling skills is also associated with injuries, including acute as well as chronic ones.

No age-related or sex-related causes could be found in the literature. Indeed, a biomechanical analysis of judo techniques revealed that both men and women use similar techniques in...
contemporary Olympic tournaments. However, women seem to be more exposed during ground fight, where their injuries are frequently derived from arm lock techniques. Moreover, the loss of balance in women was the main cause of injuries when performing throws and breakfalls. Among men, these causes were predominant in younger age classes, that is, from 10 to 19 years (about 48%), whereas being pressed against the mat by the opponent or a fall on the opponent occurred most often from the age of 20 years (33%).

Furthermore, Seoi Nage techniques, that is, the throws with ‘lever applied with variable arm’, were supposed to be high-risk techniques for shoulder injuries being thrown, and for knee injuries performing the throw in all age categories and for both genders. However, results on the frequency of knee injuries while performing this technique are discordant. Moreover, there is a high risk of repeated injuries after the first lesion sustained during these shoulder throws, mostly caused by the too quick resumption of physical activity after the sustained trauma. Also, improper technique is supposed to be involved in the injury mechanism of delivering throws.

Mechanisms of the most frequent judo injuries
The mechanisms of judo injuries are varied. A study by the French Judo Federation on 150,067 fights showed that injuries affected the shoulder in 28.7% of cases, the elbow in 13.5%, and the ankle and fingers less frequently. Glenohumeral dislocations are mostly caused by the resistance to the chin and the neck in 12.2% and the ankle and fingers less frequently.

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showed a higher percentage of injuries as they usually cover
entire careers of judokas until the moment of the questionnaire,
while prospective studies are generally oriented to shorter and
well-defined periods.

**Influence of nutrition, hydration and weight cycling on judo
injuries**

Although nutrition, hydration and weight cycling are considered
important injury risk factors in combat sports,\textsuperscript{65–67} specific
research on judo is still very scarce.\textsuperscript{67} A higher frequency of
injuries and impairment of muscular function have been found in
weight cycling judokas and among those undergoing rapid
weight reduction before a competition compared with control
groups of judo athletes.\textsuperscript{12} 68 69 Moreover, even if bone injuries
were not higher in judokas displaying disordered eating beha-
vours,\textsuperscript{70} the risk of bone injuries due to changes in bone
metabolism has been referred as a consequence of weight
cycling in judo.\textsuperscript{71} 72 Nevertheless, the strength requirements
and technical characteristics of judo practice may also be pre-
ventive factors for bone loss and bone-related injuries.\textsuperscript{73}
Furthermore, it has been reported\textsuperscript{74} that the fluid restriction
practiced by many judo athletes when involved in weight loss
processes,\textsuperscript{75} in conjunction with intense judo training in hot
environments, resulted in serious dehydration, which might
provoked heat-related injuries. Death has rarely been reported as
a consequence of dehydration in judo\textsuperscript{67} and wrestling.\textsuperscript{66}

Despite the described risks, most judo athletes reduce their
weight a short time before competition.\textsuperscript{75} 77 78 The methods
used include fluid restriction, sauna or plastic clothing, diuretics
or laxatives, or food restriction, among others.\textsuperscript{78} 79 In line with
Artioli \textit{et al},\textsuperscript{66} it can be concluded that athletes, especially pre-
pubescent ones, must avoid harmful weight loss procedures in
terms of sports injury prevention and further actions, including
specific programmes, must be promoted to dissuade judo ath-
letes from these methods. Judo should follow the example of
wrestling, where these programmes started to be implemented
since the late 1990s.\textsuperscript{76} To create a daily energy deficit of 500–
1000 kcal, a long-term soft diet and aerobic exercise have been
recommended for losing weight without harming the athletes’
health.\textsuperscript{80} More importantly, strict regulations would be the best
way to avoid dangerous weight loss practices in judo, as has
been the case for wrestling.\textsuperscript{66} 80

**Psychological factors associated with judo injuries**

The research results of recent years reinforce the assumption
that psychological factors are involved in the development of
sports injuries.\textsuperscript{81–83} The perceived similarity and control seem
to directly contribute to the perceived risk of injury.\textsuperscript{82} The per-
ceived similarity of an athlete with the ‘typical judoka who gets
injured while practicing judo’ might especially be a pathway to
the time and effort spent in analysing the risk information critic-
ally, which might lead to developing preventive actions.\textsuperscript{82} Some
studies in non-judokas refer to the three central elements of self-
determination theory (autonomy, competence and relatedness)
fostering intrinsic motivation and seem to be related to the
return to sport following injury.\textsuperscript{84} Accordingly, there is prelimin-
ary evidence that positive psychological responses (motivation,
confidence and low fear) are associated with a higher rate of
returning to sport.\textsuperscript{84}

Future research on judokas should aim at reducing injuries by
testing cognitive behavioural strategies, which have shown effi-
cacy in other sport settings, by performing randomised clinical
trials based on the extended theoretical framework of
stress-injury models.\textsuperscript{81} 85

**Injury prevention measures during training and competition**

The knowledge on judo injuries is indispensable for the devel-
opment of preventive measurements.

Considering the relatively high frequency of upper body injur-
ies being thrown in judo, to improve falling skills,\textsuperscript{25} 35 36 86 by
means of good and frequent break fall training, avoiding to fall
on the top of the shoulder or on the palm of the hand,\textsuperscript{79} should
be the highest priority of judo coaches, especially when teaching
beginners and young practitioners. Also, balance training as well
as testing the training effects in young judokas might be useful in
the evaluation and reduction of the risk of falls.\textsuperscript{88} As throw-
ing could also be dangerous, throwing techniques should like-
wise be carefully and correctly apprehended from the very
beginning.\textsuperscript{25} 35 36 86 Furthermore, it is important to have good
physical preparation, especially by stimulating long-term resist-
ance training practice,\textsuperscript{4} 4 89 90 mainly focusing on women’s
upper body strength, as a high level of strength and flexibility
showed a significantly lower injury rate.\textsuperscript{91–94}

A specific programme for ACL injury prevention with pro-
practive exercises and knowledge of the risk situations, in
addition to a higher emphasis on bilateral grips during training,
would be useful in reducing knee injuries. Changing the rules,
including the prohibition of direct attacks with the hand on the
pants, seems to reduce knee sprains.\textsuperscript{6} However, this should be
assessed more extensively in future studies. Yamamoto \textit{et al}\textsuperscript{95}
showed elastic taping to have a preventive function on ankle
instability. Additionally, the quality of the mat is also important:
even if collisions, that is, head impacts, would be attenuated on
relatively soft mats, the feet would penetrate into the mat,
which could lead to knee ligament injuries.\textsuperscript{48} A soft protective
headgear could be an option to decrease head injuries as well
as ‘cauliflower ear’.\textsuperscript{14} 57 The frequency of finger injuries has to be
assessed in future follow-up studies to determine if the recent
changes in the international judo rules from 2013 concerning
grip fight will have a positive influence.
Educational programmes
Injury prevention can be improved by providing education for athletes, coaches, referees and tournament directors and establishing minimum standards of qualification and experience for trainers and referees.\(^{35} 61 96 97\) They should also be instructed in the mechanisms, prevention and treatment of injuries.\(^{26}\) Furthermore, judokas need to be aware of the importance of entering competition fully recovered from past injuries.\(^{16} 26\) In addition, one decisive criterion of the ability to compete could be the scores in the Special Judo Fitness Test (SJFT).\(^{98}\) During the rehabilitation process, judo coaches can compare individual progress in SJFT, aiming at the achievement of the scores athletes had before sustaining the injury.\(^{26}\) Moreover, athletes should be encouraged to give up on time in case of armlocks and choking techniques\(^{14}\) as well as to interrupt the fight in case of moderate injuries. On the other hand, the role of the referee is also relevant, especially during armlocks and choking techniques, stopping the fight if the athlete is unable to give up.\(^{6}\)

It is also necessary to reflect on the re-evaluation of the current competition rules.\(^{3} 49\) Specific rules should keep on developing for the young categories having safe practice as a main concern. Hard or uncontrolled throwing, holding, joint locking or choking techniques and dangerous falling techniques, for example, trying to avoid falling on the back, can cause injuries and even serious damage,\(^{15} 19 35 62\) and should be strictly penalised for the preservation of young athletes’ health. Moreover, children and juveniles or inexperienced judokas should be prevented from entering competition prematurely.\(^{96} 99\) Competitions for athletes of different levels of experience, as those organised by the French Judo Federation, should be encouraged.

A correct pedagogical approach should not be forgotten. Studies on sports traumas indicate that the injury risk is lower if goals of achievement are proposed to players: sport exercise for health, physical maintenance or pleasure causes 9\% fewer accidents than practice driven by aspiration of good performance, success in competition or desire of taking risks.\(^{100}\) Therefore, a reorientation of performance goals to goals of achievement, especially for young judo practitioners, would probably reduce the injury risk.

CONCLUSIONS
The present review provides the latest knowledge on the frequency and characteristics of injuries in judo. Comprehensive knowledge about the risk of injury during sport activity and related risk factors represents an essential basis to develop effective strategies for injury prevention. Thus, the introduction of an ongoing injury surveillance system in judo is of the utmost importance.

What are the new findings?

- The present review provides the latest knowledge on the frequency and characteristics of injuries in judo.
- Injuries of extremities, especially of the knee, shoulder and fingers, are the most frequently affected body parts in judo practitioners.
- Sprains, strains and contusions are the most common injury types.
- Being thrown during standing fight is the predominant situation where injuries occur.

How might it impact clinical practice in the near future?

- Introduction of an ongoing injury surveillance system in judo.
- Awareness of the risk situations, with particular emphasis on the correct learning of judo techniques, bilateral grips during training and avoiding weight cycling.
- Preventive measures will focus on improving protective equipment, which could be useful especially during training.

Author affiliations
1Department of Sport Science, University of Innsbruck, Innsbruck, Austria
2Faculty of Sport and Physical Education, University of Niš, Niš, Serbia
3Combat Sports Unit, Department of Theory of Sport and Kinesiology, Institute of Sport, University School of Physical Education, Cracow, Poland
4Sports Training and Physical Performance Research Group, Federal University of Pelotas, Pelotas, Brazil
5Martial Arts and Combat Sports Research Group, Sport Department, School of Physical Education and Sport, University of São Paulo, São Paulo, Brazil
6Department of Physical and Sport Education, University of León, León, Spain
7Unit of Orthopaedic and Sport Surgery, CHU La Pitié-Salpêtrière, Paris, France
8Nollet Institute of Locomotor System, Paris, France
9Faculty of Sport Science, University of Montpellier, Montpellier, France
10National Track & Field Centre, Sports Injury Clinic, Sports Medicine Clinic of S.E.G. A.S., Thessaloniki, Greece
11Thessaloniki SPORTS Medicine Clinic, Thessaloniki, Greece

Contributors
EP contributed to the conception and design, acquisition, analyses and interpretation of the data, drafting, accurate and critical revision, and final approval of the version of the paper to be submitted. She is the guarantor. GS, SS, FBVD, CG-G and RR contributed to the analyses and interpretation of the data, drafting, critical revision and approval of the final version of the paper. MW, VM, PK and MC contributed to the acquisition of the data, drafting and approval of the final version of the paper. MK contributed to the analyses and interpretation of the data, accurate and critical revision of the paper as well as approval of the final version. BM contributed to the acquisition of the data, accurate and critical revision of the paper as well as approval of the final version. NM contributed to the conception as well as revision and approval of the final version of the draft paper. MB contributed to the conception and design, accurate and critical revision as well as final approval of the version of the paper to be submitted.

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