

## Injury prevalence in Brazilian jiu-jitsu athletes: comparison between different competitive levels

### *Prevalência de lesões em atletas de Brazilian jiu-jitsu: comparação entre diferentes níveis competitivos*

Jorge Nelson da Silva Junior<sup>1</sup>  
Rafael Lima Kons<sup>1</sup>  
Rodolfo André Dellagrana<sup>1</sup>  
Daniele Detanico<sup>1</sup>

**Abstract** – This study aimed to identify types and sites of body injury, location of injury occurrence, and the mechanism and severity of injuries in novice and advanced Brazilian jiu-jitsu (BJJ) athletes. One hundred and eight BJJ athletes took part in this study separated in two groups: advanced (n = 53) and novice (n = 55). Athletes answered a questionnaire concerning regions of injury, locality of occurrence, injury severity and mechanism. Chi square test and a logistic regression analysis were used with the level of significance set at  $p < 0.05$ . The main results showed that shoulders and knees were the most injury location reported by novice and advanced athletes. Novice athletes demonstrated higher prevalence of injuries during training sessions (54.5%), whereas advanced athletes reported more injuries during competitions (66.1%). Significant associations between novice and advanced athletes were observed for major joints ( $p < 0.05$ ). The odds ratio of having injury was 70-87% less for novice versus advanced athletes for the major joints cited. We concluded that BJJ athletes demonstrate high prevalence of injury mainly at knee and shoulder. While risk of injury appeared less in novice, the advanced demonstrated higher number of injuries during competitions as a consequence of injured joint keys. By contrast, novice athletes reported higher number of injuries associated with training sessions as a consequence of overuse.

**Key words:** Athletic injuries; Epidemiology; Sports.

**Resumo** – O objetivo deste estudo foi verificar as regiões do corpo afetadas por lesões, o local de maior ocorrência de lesão, o mecanismo e a gravidade das lesões em atletas iniciantes e avançados de Brazilian jiu-jitsu (BJJ). Cento e oito atletas participaram deste estudo, separados em dois grupos: avançados (n = 53) e iniciantes (n = 55). Os atletas responderam um questionário sobre as regiões acometidas por lesões, local de ocorrência, grau de gravidade e mecanismos. O teste do Qui-Quadrado e análise de regressão logística foram utilizados com o nível de significância de  $p < 0,05$ . Os principais resultados mostraram que o ombro e o joelho foram os locais de lesão mais citados pelos atletas iniciantes e avançados; os atletas iniciantes apresentaram maior prevalência de lesões durante a sessão de treino (54,5%), enquanto os atletas avançados apresentaram mais lesões durante as competições (66,1%). Foram observadas associações significativas entre atletas iniciantes e avançados para as principais articulações ( $p < 0,05$ ). A chance de ter lesão foi de 70-87% menor para iniciantes do que avançados nas principais articulações citadas. Concluímos que os atletas do BJJ apresentaram alta prevalência de lesões principalmente no joelho e no ombro. A razão de chance de ter lesão foi menor para atletas iniciantes do que avançados. Atletas avançados apresentaram maior número de lesões durante as competições e o mecanismo principal foram chaves articulares. Os atletas iniciantes apresentaram maior número de lesões durante as sessões de treino e o mecanismo principal foi o uso excessivo.

**Palavras-chave:** Esportes; Epidemiologia; Lesões em atletas.

1 Universidade Federal de Santa Catarina. Centro de Desportos. Laboratório de Biomecânica. Florianópolis, SC, Brasil.

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## INTRODUCTION

Brazilian jiu-jitsu (BJJ) is a combat sport that has demonstrated an increase in popularity in recent years, which is largely attributable to its inclusion in mixed martial arts (MMA)<sup>1</sup>. The primary goal of BJJ is to apply strangleholds and joint keys (e.g., wrist, elbow, knee and ankle locks) to force an opponent into submission and loss of the match<sup>2</sup>. While BJJ athletes begin combat in the standing position, most of the combat eventually ends up taking place during groundwork.

A common characteristic of BJJ is intermittent combat<sup>3,4</sup> (e.g., typical matches consist of high-intensity intermittent efforts, demonstrating effort:pause ratios from 6:1 to 13:1 and effort periods of 85–290 seconds and pauses of 5–44 seconds<sup>5-7</sup>). Because of the high intensity of matches, body strain imposed by an opponent during application of key techniques, and rapid body falls and shocks the BJJ athlete is continually exposed to increased risk for injury throughout training sessions and competitions. A recent study reported the rate of incidence associated with joint injuries is 24.9 per 1000 BJJ athlete-exposures during an official BJJ tournament<sup>8</sup>. For example, elbows and knees followed by ankles are the most commonly injured joints in BJJ athletes<sup>8,9</sup>. While rate of injury has been reported as more common during training sessions compared with competitions in other combat sports as karate, judo<sup>10</sup>, wrestling<sup>11</sup>, boxing<sup>12</sup> and taekwondo<sup>13</sup>, differences in the rate of injury incidence during training sessions compared with competition has not been explored in BJJ athletes.

Tournaments featuring BJJ consist of a spectrum of competition levels, including amateur, professional, novice, and/or advanced athletes. Supporting evidence suggests BJJ athlete experience (e.g., from purple to black belts) directly relates with higher levels of muscle power in lower limbs and handgrip strength compared with novice athletes (e.g., white and blue belts)<sup>14</sup>. By contrast, any association between level of BJJ experience and rate of injury is still unclear. A single study recently reported that during an official BJJ competition, experienced athletes demonstrated a higher risk of injuries compared with less experienced athletes<sup>8</sup>.

Increased understanding of injury prevalence associated with BJJ may aid coaches and physical trainers in identifying important information about types and location of common body injuries, mechanisms of prevalence (e.g., joint keys, overuse, etc.), and environmental setting where injuries occur (i.e., competition versus training sessions). Preventative care strategies tailored for each level of BJJ experience may also be devised based on an improved understanding of rate of injury incidence. Therefore, this study aimed to identify the different types of body injuries associated with BJJ, the environmental setting of highest injury incidence, and the underlying mechanisms and severity of injuries in novice compared with advanced athletes. We hypothesized, 1) elbows and knees will be the most injured joints for both novice and advanced athletes<sup>8,9</sup>, and 2) compared with novice athletes, advanced athletes will demonstrate higher rate of injury<sup>8</sup>.

## METHODOLOGICAL PROCEDURES

### Participants

The study sample consisted of adult BJJ athletes (N=260) who had participated in two national tournaments that occurred in Florianópolis (Santa Catarina, Brazil) from July to December in 2016. The body injury based questionnaire used to test aims of this study was sent to all athletes, but only 108 responses were returned (41%). The necessary sample size, performed post-hoc (sample error of 5% and confidence interval of 90%), showed 133 athletes would be considered as representative of the population, which is similar to what was demonstrated in this study.

The participants were divided in two groups according to the graduation level (belt color): 1) novice athletes – white and blue belt (n = 55, age  $25.64 \pm 6.31$  years, height  $176.6 \pm 6.24$  cm, body mass  $82.83 \pm 13.50$  kg and time of practice  $3.67 \pm 2.27$  years); and 2) advanced athletes – from purple to black belt (n = 53, age  $31.0 \pm 6.51$  years, height  $178.6 \pm 6.19$  cm, body mass  $82.83 \pm 8.35$  kg and time of practice  $10.0 \pm 5.59$  years). This criterion of belt graduation was previously used by Del Vecchio et al<sup>5</sup>. Time of experience was also considered and it was significantly higher in advanced athletes compared to with novice athletes ( $p < 0.01$ ). All participants had already participated in several national and state BJJ tournaments. They had been training (technical and tactical training) 4–5 days per week, with training each session on average lasting 2 hours. Ethical approval was obtained from the local Human Research Ethics Committee (protocol number: 119.014). All aspects of this protocol were written in accordance with standards set by the Declaration of Helsinki.

### Procedures and measures

A questionnaire adapted from Santos et al.<sup>15</sup> consisting of ten questions including athlete identification (e.g., age, body mass, height, belt color, years of experience in BJJ, and frequency of training) and injuries history (e.g., injury location, place of injury occurrence, mechanism of injury, and injury severity). Prior to answering the questionnaire, athletes were given an explanation of the procedures and objectives of the research. Questionnaires were filled out under the supervision of a researcher.

For injury location, specific joints including shoulder, elbow, handle, hip, knee, ankle, and hand fingers were considered. Athletes were also asked to report if the last injury occurred in training or competition as well as what was the injury mechanism (e.g., excess of training, falls, joint keys or others). Degree of injury severity identification was described according to the international injury registry severity scale<sup>16</sup>. This scale takes into account training time missed due to injury as a classification of severity as follows: light (with no time lost training), light to moderate (one to two days), moderate (two weeks), moderate to severe (two to four weeks), or severe (four weeks). A similar instrument has been use in previous studies of BJJ athletes<sup>8,9,16,17</sup>.

## Statistical analyses

Data were reported as mean, standard deviation and relative frequency. Chi-square tests were used to assess associations between injury location (shoulder, elbow, handle, hip, knee, ankle and hand fingers) and places of injury occurrence (training and competition) with regards to differences between novice and advanced athletes. Logistic regression was used to examine if injury location and occurrence were associated with competitive level (i.e., novice or advanced). All statistical analyses were performed using IBM SPSS Statistics for Windows, version 21.0 (IBM Corp, Armonk, NY, USA) software. To determine significance, the alpha level was set at  $p < 0.05$ .

## RESULTS

All participants in this study had previous injury history associated with BJJ practice. Shoulders and knees were the most common injury location in novice (shoulder = 50% and knee = 50%) and advanced athletes (shoulder = 77.4% and knee = 81.1%). Advanced athletes also demonstrated injury to ankles (67.9%) and fingers (60.3%). Significant associations between novice and advanced athletes were observed for shoulder, elbow, knee, ankle and hand fingers ( $p < 0.05$ ). Additionally, novice athletes demonstrated higher injury prevalence during training sessions (54.5%), whereas advanced athletes demonstrated more injuries during competitions (66.1%) (Table 1).

**Table 1.** Association between novice and advanced BJJ athletes for injury location and occurrence of injury (relative frequency corresponds to total of citations by the athletes).

	Novice (n = 55)		Advanced (n = 53)		X <sup>2</sup>	p-value
	No	Yes	No	Yes		
Injury location						
Shoulder (%)	50.0	50.0	22.6	77.4	8.64	0.003
Elbow (%)	77.8	22.2	45.3	54.7	11.95	0.001
Handle (%)	74.1	25.9	56.6	43.4	3.61	0.057
Hip (%)	85.2	14.8	69.9	30.1	3.63	0.057
Knee (%)	50.0	50.0	18.9	81.1	11.46	0.001
Ankle (%)	77.8	22.2	32.1	67.9	22.58	<0.01
Hand fingers (%)	68.6	31.4	39.7	60.3	8.99	0.003
Occurrence of injuries						
	Training	Competition	Training	Competition		
Injured (%)	54.5	45.5	33.9	66.1	4.63	0.031

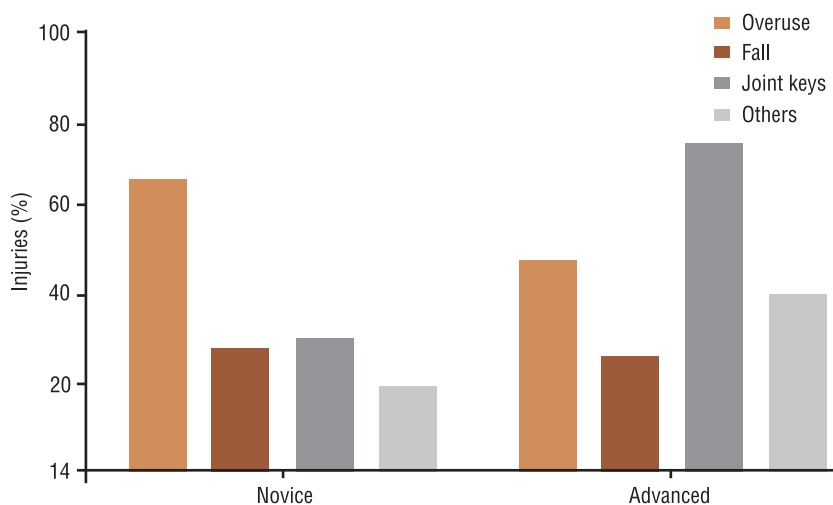
With regards to experience level (novice and advanced), logistic regression demonstrated the odds ratio of having injury in the shoulder, elbow, knee, ankle and hand fingers were 71, 77, 77, 87 and 70%, respectively, lesser for novice compared with advanced athletes. Novice athletes demonstrated an odds ratio of training session injury approximately twice that of advanced athletes. By contrast, the odds ratio associated with injury during competitions was 58% less for novice compared with advanced athletes (Table 2).

**Table 2.** Logistic regression demonstrating relationships between competition level and injury (location and occurrence).

	Advanced (n = 53)	Novice (n = 55)	p-value
	Ref	OR (CI 95%)	
Injury location			
Shoulder	1	0.29 (0.12-0.67)	0.004
Elbow	1	0.23 (0.10-0.54)	0.001
Handle	1	0.45 (0.02-1.03)	0.060
Hip	1	0.40 (0.15-1.04)	0.061
Knee	1	0.23 (0.09-0.55)	0.001
Ankle	1	0.13 (0.05-0.32)	<0.001
Hand fingers	1	0.30 (0.13-0.66)	0.003
Occurrence of injury			
Training	1	2.33 (1.07-5.07)	0.033
Competition	1	0.42 (0.19-0.93)	0.033

OR = odds ratio, CI = Confidence interval, Ref. = reference.

The main injury mechanism in novice athletes was overuse (excess of training) (66%), which was followed by joint keys (29%), falls (27%), and other (18%, sprains and beats). In contrast, the main injury mechanism in advanced athletes was joint keys (75%) followed by overuse (47%), falls (26%), and other (39%, sprains and beats) (Figure 1).

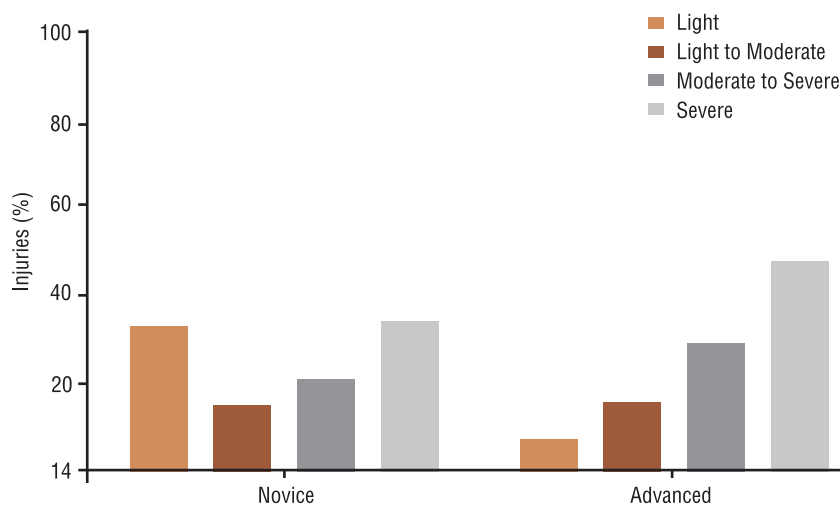


**Figure 1.** Frequency of mechanisms involving injuries in novice and advanced BJJ athletes.

Novice athletes demonstrated more severe (35%) and light injuries (33%), whereas advanced athletes showed more moderate to severe (31%) and severe injuries (49%) (Figure 2).

## DISCUSSION

The purpose of this study was to identify body regions affected by injury, environmental setting of occurrence, and the mechanism and severity of injuries in novice BJJ compared with advanced ones. Shoulder and knee were the



**Figure 2.** Degree of severity involving injuries in novice and advanced BJJ athletes.

most injured regions in both novice and advanced athletes, which is consistent with our first hypothesis. Although athletes did not report elbows as the most frequent site of injury, prevalence at this location amounted to 54.7% and 22.2% of total citations for advanced and novice athletes, respectively.

Injuries incurred at joints of BJJ athletes may be related to techniques used in matches and training sessions. During the course of BJJ combat, athletes perform specific techniques to defend joint keys while increasing risk of injury, particularly at knees, elbows, and shoulders. Consistent with our observations, Kreiswirth et al.<sup>8</sup> reported a high injury rate during a BJJ World Championship in 2009, particularly at knees (19.4%), shoulders (16.1%) and elbows (19.4%). Scoggin et al.<sup>9</sup> while analyzing data from BJJ tournaments in Hawaii from 2005 to 2011 concluded that 19.4% of knee injuries occurred from direct pressure, particularly during passing guard (11.1%). The same authors reported shoulder injuries to be most commonly caused by the kimura technique (joint key in the shoulder).

In team sports several studies have reported that hamstrings/quadriceps and external/internal rotators ratios may be a possible mechanism underlying knee<sup>18,19</sup> and shoulder<sup>20,21</sup> injuries, respectively. This is relevant as BJJ combat presents higher effort:pause ratio (from 6:1 to 13:1)<sup>5,7</sup> compared with other combat sports such as judo (2:1 to 3:1)<sup>22</sup> and Greco-Roman wrestling (2:1)<sup>23</sup>. Therefore, strength imbalances associated with high intensity efforts that combine different integration and application of joint keys techniques could be related to high joint injury rates in BJJ athletes.

In providing support for our second hypothesis, we demonstrated significant associations between novice and advanced athletes for the joints (i.e., shoulder, elbow, knee, ankle and hand fingers), suggesting injury rate increases in advanced athletes. Likewise, we demonstrated from the logistic regression analysis that the odds ratio of having injury appeared 70-87% less for novice compared with advanced athletes for the major joints cited.

Consistent with these data, it has been reported by others that the more experience of collegiate-aged wrestlers (divisions I and II), the higher the

incidence of injury compared with novice wrestlers (division III)<sup>24</sup>. Yard et al.<sup>25</sup> also observed higher injury rates increased as competition experience level increased for wrestlers. On the other hand, in BJJ athletes, Kreiswirth et al.<sup>8</sup> demonstrated novice and advanced athletes have similar injury rates (5.3 and 8.3%, respectively), suggesting cause of injury is more related to inherent technique than skill in performing submission maneuvers. Thus, we suggest higher injury rate for advanced BJJ athletes showed in this study could be related to the high technical level of opponents since matches are divided according to belt color. Also possibly contributing to injury prevalence, advanced BJJ athletes demonstrated higher frequency of practice and match competition compared with novice athletes.

Novice BJJ athletes demonstrated an odds ratio of training session injury approximately twice higher than advanced athletes. This supports our hypothesis that the majority of combat athlete injuries occur during training<sup>10,12,13</sup> as a function of experience level in combat sports training<sup>26</sup>. While novice athletes typically have less formal match competition during the season, the increased frequency of practices is consistent with overuse (excess of training) as the most cited injury mechanism in novice athletes compared with advanced athletes where joint keys were the most cited cause of injury.

Traditional BJJ training sessions generally consist of warm-ups (30 minutes) and combats simulations (60 minutes)<sup>27</sup> where all athletes train together independent of belt graduation, body weight, or experience time. In training sessions, novice athletes usually perform several matches against more experienced athletes. This leads to injury risk that is higher compared with formal competitions where matches are divided by belt color and weight<sup>28</sup>.

According to the severity scale of injury, which considers training time lost due to injury, novice athletes reported a high rate of severe and light injuries, whereas advanced athletes most frequently reported moderate to severe and severe injuries. This suggests that advanced athletes demonstrated increased training time lost due to injury as a likely consequence of falls and knocks during matches in formal competition. By contrast, injuries of novice athletes mainly caused by overuse (excess of training) resulted in no training time lost due to injury or low- to- moderate time lost (e.g., two to four weeks).

Moderate or severe injuries are common for combat sports. For example, boxing athletes presented 33 days lost per injury<sup>12</sup> and for taekwondo athletes 32% of injuries result in >1 week training time lost (i.e., moderate or severe)<sup>13</sup>. Considering severity of injuries, our results suggest the rate of moderate or severe injuries on BJJ novice and advanced athletes are high. Therefore, these data provide new insight as to how one might implement injury prevention programs within the sport of BJJ.

Relevant to coaches and physical trainers, these data suggest that it is important to consider competition level during training session activities in some as well as include specific strength training programs in order to

prevent muscle imbalance and weakness, particularly in novice athletes. Specific evaluation methods such as isokinetic dynamometers and motion assessment methods including Functional Movement Screening (FMS) may be applicable for physically assessing BJJ athletes<sup>29</sup>.

## CONCLUSION

We concluded that BJJ athletes demonstrated high prevalence of injury primarily at knee and shoulder. While risk of injury appeared less in novice, the advanced reported higher number of injuries during competitions as a function of moderate- to- severe injury at joint keys. By contrast, novice athletes presented higher number of injuries during training sessions as a consequence of overuse, whereby the degree of severity being reported as light- to- moderate. As a next step, we suggest longitudinal studies should be performed to analyze risk of injury over the course of a season as well as separate studies performed to assess specific strength training programs useful for preventing muscle disorders and injuries. In addition, further researches should compare data obtained from questionnaires with medical reports, allowing more accurate results related to BJJ injuries.

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#### **CORRESPONDING AUTHOR**

Rafael Lima Kons  
Universidade Federal de Santa  
Catarina. Centro de Desportos.  
Laboratório de Biomecânica.  
Campus Universitário da Trindade.  
CEP: 88040-900 Florianópolis (SC)  
Brasil  
E-mail: [rafakons0310@gmail.com](mailto:rafakons0310@gmail.com)