



RESEARCH ARTICLE

Factors that Influence Injuries Occurrence in Jiu-Jitsu Competitors

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Abstract

The Brazilian Jiu-Jitsu (BJJ) is known for its efficiency and competitiveness, the modality has shown an increase in the practitioner's number and international level competitions, leading to worldwide popularization. Even with worldwide success and recognition, the number of studies on the modality did not follow this growth, which makes it difficult to categorize the sport and identify the factors related to injuries, which is essential to promote and plan interventions aiming at injury prevention. This study aimed to identify the factors related to injuries in competitors during a regional championship. This is a descriptive epidemiological cross-section, where the sample was selected for convenience. The sample was composed of 374 BJJ practitioners who competed in the regional championship, and they answered a questionnaire with 17 questions about the sports practice and injuries in BJJ. The competitors are in the adult and master categories according to age, in the light, medium, and super-heavy categories, based on weight, and they used to practice BJJ by hobby, between 3 and 4 times a week. Most participants (58.8%) reported already having been injured and the most injured structures were knee (32.7%) and shoulder (16.8%). The most-reported diagnoses were a ligament injury with (22.1%). According to with *Odds Ratio* analysis, the occurrence chance of injury is greater the longer the practice time in BJJ, when compared to those who practice less than 1 year, the chance of injury is 3 times greater in competitors who train 3-4 times a week than in competitors who train 1-2 times, and 6 times greater in competitors who train 5-6 times a week. The injury occurring chance is greater the longer the fighter practices the BJJ and the bigger the training frequency. The injury chance also increases in cases where the practitioner feels pain during warm-up. In contrast, the chance of injury is less as the duration of the warm-up period increases.

Keywords

Sports medicine, Martial arts, Population characteristics, Cumulative trauma disorders

Abbreviations

BJJ: Brazilian Jiu-Jitsu; MMA: Mixed Martial Arts; SPSS: Statistical Package for the Social Sciences; KG: Kilograms

Introduction

The Brazilian Jiu-Jitsu (BJJ) it's a grappling martial art, the word Jiu-Jitsu means gentle art and its purpose is to submit the opponent, which is to force them to give up the fight. This is achieved using techniques based on the levers system, by positioning a joint beyond the physiological limit of the range of motion [1,2].

The literature has many papers on the benefits of physical activity for health [3], and about martial arts benefits [4]. As a physical activity, BJJ gives the practitioner access to a highly competitive modality that presents benefits for the body and mind, working large muscle groups, motor coordination, strength, balance, and self-confidence [5,6]. BJJ can be defined as an intermittent exercise, where it presents a high-intensity effort with a short rest period, with predominantly anaerobic lactic metabolism [7,8].

The BJJ is known for its efficiency and competitiveness, the modality has shown an increase in the number of practitioners and competitions of international level, leading to the worldwide popularization of the BJJ

[2,9,10]. The modality has gained characteristics of the sport, being practiced by individuals who aim to be athletes, but also by individuals who seek to improve their habits of life and work their body and mind [6,10].

Another factor related to the worldwide recognition of BJJ is the growth of Mixed Martial Arts championships (MMA), where BJJ is one of the historical bases of the sport, and today, it is one of the main ways to compete in MMA [2,5]. In addition to having a historical representation in the biggest MMA tournament in the world, the Ultimate Fight Championship (UFC) [2,11]. BJJ techniques besides providing finalization can guide the fight for the knockout through takedowns, projections, and dominance positions on the ground.

Even with the growth in the number of participants, worldwide success and recognition, the number of studies on the modality did not follow this growth, which makes it difficult to categorize the sport. The studies already define BJJ as a modality with high injury rates [1,12], but there is a gap in identifying which techniques are involved in the occurrence of injuries and relating them to the body part and the practitioner's experience.

The injuries can be caused by intrinsic and extrinsic factors or both, the intrinsic factors are those related to the individual characteristics of the competitors, such as anthropometric characteristics, nutrition, and psychological factors. The extrinsic factors are those related to the environment, climate, equipment, training, and specificities of the modality [13]. The injury of the practitioner impairs the performance, which can lead to interruption of training and competition [14], and efforts should be made to avoid them, investigating the population is one of the most important factors for this [15].

Considering the number of studies on the factors influencing the occurrence of injuries in BJJ, specifically in the population of competitors in Brazil, the present study aims to identify the factors related to injuries in competitors during a regional championship.

Methods

This is a descriptive epidemiological study, in which 374 Jiu-Jitsu practitioners of both sexes participated, with an average age of 24 ± 8 years, varying between 13 and 71 years. The sample was selected for convenience, during the "XIV Copa Leão Dourado de Jiu-Jitsu", a regional competition held by the *Liga Brasileira de Jiu-Jitsu*, held in the city of Betim, Minas Gerais, in 2011. All participants signed the informed consent form agreeing to participate in the research and answered a questionnaire composed of 17 questions (objective and discursive). Through an interview conducted by academics from the physiotherapy course at the Pontifical Catholic University of Minas Gerais.

The questionnaire was developed and applied to BJJ practitioners by academics from the physiothera-

py course of the Pontifical Catholic University of Minas Gerais - Brazil, under the guidance of experienced physiotherapist in research, and aimed to collect information to characterize the competitors practice in BJJ and injuries associated with it.

A descriptive analysis was carried out to characterize the interviewees and their activities. The evaluation of the factors that influence the occurrence of injuries and the analysis of the injuries that occurred were made through the construction of a logistic regression model and by frequency tables, respectively. Hosmer and Lemeshow statistics were used to analyze the regression model. The level of significance used in the analyzes was 5% and the program used was the Statistical Package for the Social Sciences (SPSS) version 16.0. To verify the significance of the model, a Chi-Square analysis was applied.

Results

A total of 374 BJJ competitors were interviewed, the majority (93.6%) were males. The bodyweight of the competitors was on average 77.8 kilograms (kg), varying from 41 to 150 kg. A very low percentage of participants identified themselves as professional BJJ fighters (1.1%).

Most BJJ practitioners (70.3%) perform some other physical activity, with weight training (32.1%) and soccer (13.6%) being the most frequent. Other fights (Muay Thai and Boxing) were also mentioned, but less frequently (4.8% and 2.1%, respectively).

Considering the category by age, the majority of BJJ practitioners are in the categories Adult (47.3%) and Master (19.8%), totaling 67.1% of the sample. According to the weight, the interviewees are divided into categories, with the highest categories for the categories: middleweight (21.1%), light and super heavy (16.8% each), and medium-heavy (14.7%).

The majority of the sample reported practicing sport by hobby (79.9%) and concerning practice time, most of them presented between 1 to 3 years (30.7%) and their graduation varied greatly (Table 1), the majority classified in the white (31.6%) and yellow (20.6%) belts, characterizing the sample as a beginner, which corroborates with the practice time previously presented, however, a considerable percentage is also pointed to the blue (16.8%), purple (11%) and black belt (10.2%).

The sample was questioned on how many times they train BJJ in the week; most reported practicing the fight 3 to 4 times a week (51.6%), but a high percentage practiced 5 to 6 times (31%), presenting an average daily time of two hours of training and almost all (99.2%) perform some warmup before training, with an average duration of 30 minutes. The warming done by BJJ competitors is, in most cases, prepared by a graduated black belt (73.3%). Most of the interviewees (88%) didn't re-

port pain or discomfort during warmup. However, those who reported pain reported most pain in the knees (42.2%) and in the shoulders (20%).

When questioned if they were already injured practicing the modality, the majority (58.8%) reported already having been injured. Those who had already suffered an injury answered a series of questions. The characterization of the lesions is presented in Figure 1. For this part of the study will be considered the 220 competitors (those who reported having already suffered an injury), considering that each could have cited a maximum of three injuries.

As can be seen in Figure 1, most interviewees who were injured during the practice report having suffered one injury (67.3%), and most of them (39.4%) suffer the injury between 1 to 3 years. A total of 314 lesions involving several parts of the body were recorded. The most

injured structures were knee (32.7%), shoulder (16.8%), ribs (9.2%), elbow (8.9%), and fingers (7.6%). The time since the occurrence of the lesion varies, but most competitors suffered injury one year or less before the study (55.1%). To visualize the relationship between injury, age, and graduation in the BJJ, a graph was constructed to present this relationship (Figure 2). In this figure it is possible to observe the distribution by age and how the longer the practice in sport increases the number of individuals who already suffered an injury. Concerning the situation in which the injury occurred, the majority reported having been injured during training (86.3%).

The BJJ competitors who have suffered injury were asked about the technique practiced at the time of injury and the data are shown in Table 2. There were several techniques cited, the most of the sample don't remember how the technique was practiced when they suffer an injury (37.6%), takedowns (18.5%) were the most damaging techniques followed by armbar (6.4%). Injuries occurred practicing other techniques and variations

Table 1: Graduation in Jiu-Jitsu.

Belts	Frequency	%
White	118	31.60%
Yellow	77	20.60%
Orange	5	1.30%
Green	5	1.30%
Blue	63	16.80%
Purple	41	11.00%
Brown	27	7.20%
Black	38	10.20%
Total	374	100%

Note: It is important to mention that the belt system used in 2011 according to the definitions of the Liga Brasileira de Jiu-Jitsu/International Brazilian Jiu-Jitsu Federation is no longer used. The current model, the yellow belt is aimed only at practitioners under the age of 16 years, at the time of collecting data, adults could receive the yellow belt.

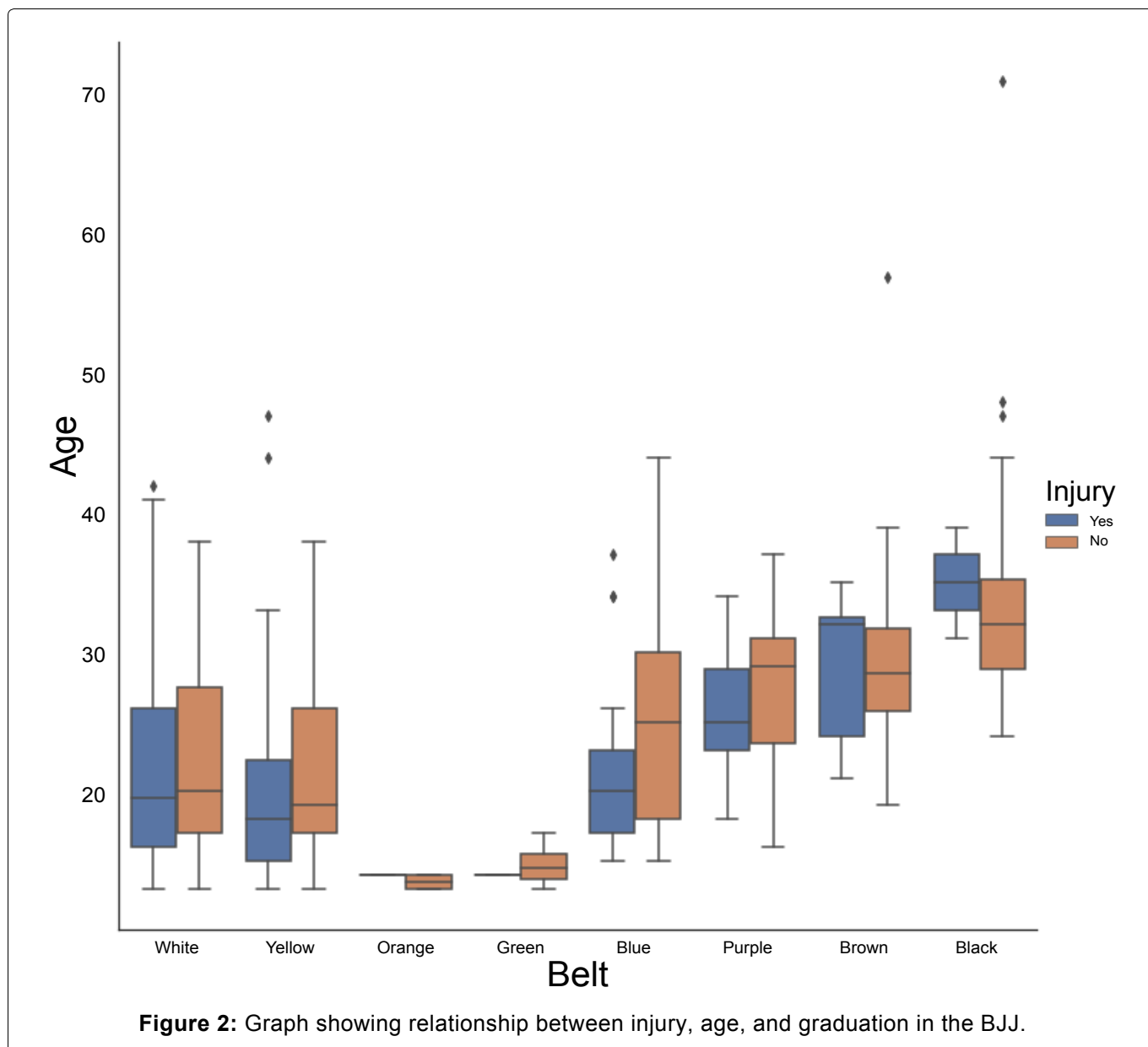
Table 2: Techniques practiced when injuries occurred.

Techniques	Frequency	%
Takedowns	58	18.50%
Armbar	20	6.40%
Guard pressure	15	4.80%
Sweeps	12	3.80%
Forward Roll	12	3.80%
Kneebar	9	2.90%
Kimura	7	2.20%
Guard pass	7	2.20%
Other	56	17.80%
Don't remember	118	37.60%
Total	314	100%

Numbers of injuries practicing BJJ



Figure 1: Number of injuries practicing BJJ.



represent 18.5%.

When questioned about the impact on injury in training, 20.4% of the competitors stayed away for 15 days, and for 24.5% they remained from 1 to 6 months without training because of the injury suffered. Most of the competitors who suffered injuries, 197 (62.7%), sought medical attention, and received a diagnosis. However, 131 (41.7%) didn't know/didn't remember the diagnosis. Among those who were able to respond, the most reported diagnoses were a ligament injury with 69 cases reported (22.1%), luxation/subluxation with 37 (11.8%), and fracture with 29 cases (9.20%). Of the 314 registered injuries, the majority (89.5%) received some type of treatment, where physiotherapy (22.6%), medication (22.3%), and ice (11.5%) were the most cited.

Factors that impact on injury occurrence

From the information obtained through the application of the questionnaire to the interviewees, some variables were chosen for the initial analysis, which will indicate whether there is a relationship between it and

Table 3: Result of the individual models with each variable.

Variável	Wald	P-valor
Man	10.866	0.001
Age	21.008	0.000
Weight	14.664	0.000
Practice other physical activities	13.888	0.000
Frequency of other physical activities	14.393	0.000
How long they practiced other physical activities	8.328	0.004
Injured while practicing other physical activities (yes)	4.959	0.026
How long ago he injured practiced other physical activities	2.321	0.677
1 to 3 years	0.143	0.706
3 to 5 years	0.641	0.423
5 to 7 years	1.537	0.215
More than 7 years	0.000	1.000
Age Classes	28.614	0.000
Teen	0.363	0.547

Adult	1.628	0.202	Yellow	0.013	0.909
Master 1	20.799	0.000	Orange	1.537	0.215
Master 2	5.504	0.019	Green	1.537	0.215
Master 3	0.000	1.000	Blue	1.901	0.168
Master 4	0.320	0.571	Purple	9.679	0.002
Master 5	0.000	0.999	Brown	5.715	0.017
Weight Classes	15.279	0.054	Black	15.829	0.000
Light Feather	0.111	0.739	How many times a week did BJJ	27.664	0.000
Feather	1.901	0.168	3-4 times a week	2.276	0.131
Rooster	0.000	1.000	5-6 times a week	24.668	0.000
Middle	6.499	0.011	7 times a week	0.719	0.396
Medium-Heavy	3.014	0.083	Training duration	12.209	0.000
Heavy	0.000	1.000	Performed warm-up before training	11.966	0.001
Super Heavy	1.111	0.292	How long the heating lasted (longest duration)	5.679	0.017
Ultra-Heavy	2.644	0.104	Who prepared the warm-up	12.622	0.013
Practice for hobby	7.687	0.006	Physiotherapist	0.000	1.000
Practice time at BJJ	35.276	0.000	The athlete himself	9.052	0.003
1 to 3 years	1.945	0.163	Another athlete	1.111	0.292
3 to 5 years	0.091	0.763	Black belt certificate	2.460	0.117
5 to 7 years	2.380	0.123	Training was monitored by those who prepared	7.583	0.023
7 to 9 years	9.225	0.002	Part of the training	0.000	0.999
9 to 11 years	6.779	0.009	The whole training	7.583	0.006
More than 11 years	14.855	0.000	Reported pain during warm-up	10.584	0.001
Belt rank in BJJ	36.211	0.000			

Table 4: Results of the statistical model.

Variable	B	Wald	p-value	Odds Ratio	Interval	
					Inferior Limit	Superior Limit
BJJ practice		27.405	0.000			
1 to 3 years	0.718	5.932	0.015	2.051	1.151	3.656
3 to 5 years	0.251	0.418	0.518	1.285	0.600	2.751
5 to 7 years	0.647	1.762	0.184	1.911	0.734	4.970
7 to 9 years	1.616	9.565	0.002	5.031	1.807	14.006
9 to 11 years	1.636	7.210	0.007	5.137	1.556	16.959
More than 11 years	2.398	15.960	0.000	11.000	3.392	35.672
Week practice		18.498	0.000			
3 to 4 times	1.116	8.078	0.004	3.053	1.414	6.592
5 to 6 times	1.804	17.599	0.000	6.073	2.615	14.107
More than 7 times	0.793	1.702	0.192	2.211	0.671	7.278
Duration of warmup	-0.016	3.130	0.077	0.985	0.968	1.002
Pain during warmup	0.724	2.998	0.083	2.062	0.909	4.680

the occurrence of injury. Each variable was tested individually to verify its significance. For these analyzes, the Wald test was used, and the level of significance considered was $p\text{-value} < 0.05$. The results are shown in Table 3. Only the variables used ($p\text{-value}$ less than 0.05) were included in the complete model.

The model where there was the greatest explanation of the data variability and the best fit for the case is shown in Table 4. This model involves the variables:

“Time of practicing jiu-jitsu”, “Weekly practice of jiu-jitsu”, “Duration of warm-up” and “Pain or discomfort during warm-up”.

The variables contained in Table 4 are shown to be necessary to the model, given that the $p\text{-value}$ of the tests is less than or close to 0.05 (the variables whose $p\text{-value}$ was close to 0.05 were maintained in the analysis). The test presented in Table 5 indicates the significance of the final model built.

According to the Exp (B) (*Odds Ratio*) value shown in Table 4, it can be said that:

- 1- The chance of injury occurring is greater the longer the interviewee practices jiu-jitsu when compared to the interviewees who practice less than 1 year.
- 2- The chance of injury occurring is 3 times higher in practitioners who train 3-4 times a week than in practitioners who train 1-2 times. This value increases to 6 times in practitioners who train 5-6 times a week.
- 3- The longer the duration of the warm-up, the less chance of injury.
- 4- When the interviewee feels some pain or discomfort while warming up, the chance of having an injury is 2 times greater than that of someone who does not feel the pain or discomfort while warming up.

Table 6 shows the percentage of correct classifications made using the constructed model. It is observed that 66.9% of the observations were correctly classified concerning the occurrence of injury.

The result of the Hosmer-Lemeshow test (chi-square = 5.778; p-value = 0.672) indicates a good fit of the model built to relate the factors associated with the occurrence of injuries in BJJ practitioners.

Discussion

Brazilian jiu-jitsu is a sport of physical contact that, despite its general health benefits, involves techniques that predispose its practitioners to injuries [5,7,12,16-19], as also found in the present study, in which the majority of the competitors (58.8%) reported having been injured as a result of practicing the sport. Many factors can be associated with the occurrence of these injuries; in the present study, sports experience and training frequency are among the main causes of injuries.

Sports-related injuries can result from intrinsic and extrinsic factors, being associated to overuse; direct contact, and lack of conditioning and soft tissue insufficiency [13,20]. In the case of BJJ specifically, overuse

and direct contact factors can be the main causes of injuries in its practitioners. The dynamics and especially the techniques of the BJJ fight generate overloads in the joints (mainly in the joints of the upper and lower limbs) by forcing them to the extreme range of motion, often overcoming the tolerance of the tissues, which can result in microtrauma and, consequently, pain (approximately 12% of respondents reported the presence of pain associated with BJJ). This overload can occur during a single episode of the execution of a certain movement or due to repetitive movements [13,21].

In the present study, knees (32.7%) and shoulders (16.8%) were the joints most cited as injured by the interviewees. Ligament injuries (22.1%) and dislocation/subluxation (11.8%) were the most common, with takedowns (18.5%) and armlock (6.4%) being the most cited techniques as the cause of these injuries.

Injuries to the knee joint can be caused by a direct attack, as a kneebar (2.9%) or by transitions, like guard pressure (4.8%), sweeps (3.8%) and takedowns (18.5%) [9,22]. This probably occurred due to a body rotating around a fixed knee that is bearing weight, common to happen on takedowns, guard pressure, and sweeps, causing knees sprains [9,22,23]. Tegner [24] reports that throws and forward roll, when poorly executed, can cause trauma to the shoulders and lateral side of the knee, and that the anterior face of this joint can also be injured against the ground when the practitioner is over the opponent. Additionally, some sweeping techniques or joint attacks (kneebar), put the knee in flexion and internal rotation against the opponent's strength and knee extension, respectively. There is a relationship between this joint overload and the occurrence of ligament injuries [9]. According to Gurgel [25], in the execution of sweeps, a movement in which the BJJ practitioner is under the opponent and aims to unbalance him to invert the positions, the knee joint is often placed in a position of maximum extension against a load equivalent to the weight of the fighter, which makes the knee vulnerable to trauma.

Regarding shoulder injuries, the results found in the present study contradict other studies that report the elbow as the most affected joint [5,9]. However, the difference observed between the number of injuries between shoulders and elbows is low in other studies [12,18]. This fact can probably be related to the different techniques used in throws and armlocks, which can

Table 5: Omnibus test for model coefficients.

	Chi-square	p-value
Model	73.23	0.000

Table 6: Percentage of correct classifications made using the constructed model.

		Injury?		% of correct ratings
		No	Yes	
Injury	No	71	77	48.0%
	Yes	43	171	79.9%
Total				66.9%

affect the shoulders and elbows separately or simultaneously in a single stroke [9,26]. The armbar aims to cause hyperextension of the opponent's elbow [9] and to defend this attack, it is common to perform a lock with the hands (*hadaka*) and simultaneously a turn in the opposite direction to that of the attacked arm; a failure to defend the attack and/or a delay to signal the withdrawal from the fight can damage not only the elbow but also the anterior shoulder capsule [1]. Carpeggiani [27] reports that the force applied by the fighter during the blow is only interrupted with the opponent's withdrawal, which is usually due to some exacerbated painful stimulus. This can be secondary to an immediate trauma (dislocations, for example) or due to a pre-existing injury to the joint structures due to overuse. In the specific case of competitors. Pocceco, et al. [22] concluded that luxation and joint sprains are more prevalent among adult athletes and competitors, as they have higher levels of muscle strength.

According to the literature, falls and armlocks are the most common injury mechanisms among competitors [1,9], while in individuals who practice sport as a hobby, the injury is more often caused by armlocks [12]. This difference may be because, normally, in competitions, the fight starts in the standing position, which is not always the case in training situations. Competitors normally train their takedown techniques more than non-competitors, as the competition rule rewards a takedown with points [28,29]. Even if there is a variation between competitors and non-competitors, the moment when the injury occurs is the same, the training. The injuries can lead to time loss, the competitor being unable to take a full part in training and/or competition [24]. In this study, who suffers an injury as a result of being away from sports practice at least for 1 month, similar to other findings [1,12]. Most of the participants reported practicing sport by hobby (79.9%). Therefore, a serious injury occurred during training can impact activities of daily living and employment, serious injuries are not common in martial arts [30], but in BJJ 34% of injuries are considered serious [1], which can lead to a high impact on the practitioner's life.

According to the *Odds Ratio* analysis, the chance of injury occurrence is greater the longer the practice time in BJJ, when compared to those interviewed who practice less than 1 year, the chance of injury is 3 times greater in competitors who train 3-4 times a week than in competitors who train 1-2 times, and 6 times greater in competitors who train 5-6 times a week. Also, *Odds Ratio* findings with the majority of injuries occurring during training (86.3%), probably the BJJ injuries are related to extrinsic factors [13], when the high volume of training, many drills of the same technique, can lead to an overuse injury, direct blows to a joint (eg, armbar drills) can cause stretching of ligaments beyond the normal physiological range and permanent deformation [23], when multiple accumulative bouts of energy

transfer could result in this kind of injury [29]. Another extrinsic factor can be related to injuries in BJJ, such as strength and conditioning programs and the use of protective equipment, like a thicker mat to reduce the impact on takedowns [31].

The *Odds Ratio* suggests that longer warm-up time, leads to a lower chance of injury, perhaps the warm-up prepares the body for the jiu-jitsu practice, despite the literature don't have a consensus about the relationship between warm-up and injury prevention [32]. When the practitioner feels some pain or discomfort during warm-up, the chance of having an injury is 2 times greater than that of those who do not feel it during warm-up, which reinforces the possibility that extrinsic factors are deeply related to injuries in the BJJ.

The findings in that study make it clear that BJJ is a sport with a high injury rate. Such Injuries can lead the fighter to develop joint instabilities more easily; therefore, it is suggested the inclusion of joint protection work as a way of preventing injuries in BJJ practitioners. According to the findings, competitors who warm-up before training suffer fewer injuries, the warm-up can evoke temperature, metabolic, neural, and psychology-related effects [23,33], but the type of warm-up carried out is very varied between teachers from different teams. As reported by 73.3% of the competitors, the person responsible for the warm-up is the black belt, which is recommended, but the black belt formation is not focused on injury prevention exercises but BJJ techniques. Therefore, it is recommended that the uniformity of this warm-up by a health professional, not to replace the teacher, but to train him for this task, mainly since most injuries occurred at the time of BJJ training. The professor needs to understand that a lower incidence of injury increases the permanence of students in the gym who only want to practice a sport and also increases the chance of success for the athletes and the team.

In this sense, we believe that neuromuscular training and proprioception training can be effective in preventing injuries, due to the ability to prepare and strengthen the body for the specific demands of the sport [34,35] and to be carried out for at least 30 minutes. Also, neuromuscular and proprioception training can be performed in the form of a drill, which would not hinder anything because it is a common exercise in BJJ training. Further studies must investigate how is the BJJ warm-up and preconize an injury prevention protocol [10], as already has been well done in soccer [36], the most popular sport in Brazil and the world.

An important point to be highlighted is that in the present study, individuals aged 13 to 71 years were included, that is, the model did not rely only on data from adults. The age showed a correlation with the chance of injury, but only for the master category, which again reinforces the issue of extrinsic factors related to injury,

probably related to chronic unbalances leading to injuries. After realizing the analysis of the data and compare to the literature, no study was found related to the practice of BJJ in children, related to injury or not. The time of practice of BJJ influences the occurrence of injury, but it would be interesting to study the effects on those who practice since childhood and those who started practicing in adulthood.

Conclusion

About the occurrence of injuries, it is concluded that the chance of injury occurring is greater the longer the fighter practices the BJJ and the longer the number of training days. The chance of injury also increases in cases where the practitioner feels pain during warm-up. In contrast, the chance of injury is less as the duration of the warm-up period increases. The authors know the limitations of linear analysis used in the present study, however, know the factors related to injuries prevalence it's the first step to prepare a specific protocol. Besides, authors encourage competitors and professors, to monitor these variables in the training plan, all aiming for the reduction in the incidence of injury in BJJ competitors.

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Author Contribution Statements

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References

- Machado AP, Machado GP, De Marchi T (2012) A prevalência de lesões no Jiu-Jitsu de acordo com relatos dos atletas participantes dos campeonatos mundiais em 2006. *ConScientiae Saúde* 11: 85-93.
- Bergfeld JA, Gelber J, Lynch SA, Seidenberg PH, Piedade SR (2019) Judo, Brazilian Jiu-Jitsu, Wrestling, and Mixed Martial Arts. In *The Sports Medicine Physician* 671-682.
- Mazyarkin Z, Peleg T, Golani I, Sharony L, Kremer I, et al. (2019) Health benefits of a physical exercise program for inpatients with mental health; a pilot study. *Journal of psychiatric research* 113: 10-16.
- Origua Rios S, Marks J, Estevan I, Barnett LM (2018) Health benefits of hard martial arts in adults: A systematic review. *Journal of Sports Sciences* 36: 1614-1622.
- Kreiswirth EM, Myer GD, Rauh MJ (2014) Incidence of injury among male Brazilian jiu-jitsu fighters at the World Jiu-Jitsu No-Gi Championship 2009. *Journal of Athletic Training* 49: 89-94.
- Pope M (2019) Flow with the go: Brazilian Jiu Jitsu as embodied spirituality. *Practical Theology* 12: 301-309.
- Andreato LV, Lara FJD, Andrade A, Branco BHM (2017) Physical and physiological profiles of Brazilian jiu-jitsu athletes: a systematic review. *Sports Medicine-Open* 3: 9.
- Ide BN, Souza-Junior TP, McAnulty SR, de Faria MA, Costa KA, et al. (2019) Immunological Responses to a Brazilian Jiu-Jitsu High-Intensity Interval Training Session. *Journal of Human Kinetics* 70: 115-124.
- Scoggin III JF, Brusovanik G, Izuka BH, Zandee van Rilland E, Geling O, et al. (2014) Assessment of injuries during Brazilian jiu-jitsu competition. *Orthopaedic journal of sports medicine* 2: 2325967114522184.
- James LP (2014) An evidenced-based training plan for Brazilian jiu-jitsu. *Strength & Conditioning Journal* 36: 14-22.
- Robbins T, Zemanek J (2017) UFC pay-per-view buys and the value of the celebrity fighter. *Innovative Marketing* 13: 35-46.
- Nunes RDM, Ribeiro CC, Alves LR, da Silva Carvalho IL, de Souza Vale RG (2017) Prevalência de lesões em praticantes de Jiu-Jitsu: um estudo descritivo. *Revista de Educação Física/Journal of Physical Education* 86.
- Saragiotto BT, Di Pierro C, Lopes AD (2014) Risk factors and injury prevention in elite athletes: a descriptive study of the opinions of physical therapists, doctors and trainers. *Brazilian Journal of Physical Therapy* 18: 137-143.
- Von Rosen P, Kottorp A, Fridén C, Frohm A, Heijne A (2018) Young, talented and injured: Injury perceptions, experiences and consequences in adolescent elite athletes. *European Journal of Sport Science* 18: 731-740.
- Junior H, Luiz C, Barboza SD, Van Mechelen W, Verhaegen E (2015) Measuring sports injuries on the pitch: a guide to use in practice. *Brazilian journal of physical therapy (AHEAD)* 00-00.
- Vidal Andreato L, Del Conti Esteves JV, Ferreira Julio U, Leme Gonçalves Panissa V, Hardt F, et al. (2017) Physical performance, time-motion, technical-tactical analyses, and perceptual responses in Brazilian jiu-jitsu matches of varied duration. *Kinesiology: International Journal of Fundamental and Applied Kinesiology* 49: 30-40.
- Moriarty C, Charnoff J, Felix ER (2019) Injury rate and pattern among Brazilian jiu-jitsu practitioners: A survey study. *Physical Therapy in Sport* 39: 107-113.
- Aranda LC, Nascimento LM, Werneck FZ, Vianna JM (2014) Sports injuries: a study of athletes practicing jiu-jitsu. *EFDeportes.com, Revista Digital*.
- Júnior NSR, Silva NCR (2014) A ocorrência de lesões na prática de Jiu-Jitsu em academias de Floriano-PI. *Journal of Health Sciences* 16.
- DeLisa JA, Currie DM, Martin GM (2002) *Medicina de Reabilitação: passado, presente e futuro. Tratado de medicina e reabilitação: princípios e prática* 1.
- Sarhrmann SA (2005) *Diagnóstico e tratamento das síndromes de disfunção do movimento*. São Paulo: Santos Editora.
- Poecco E, Ruedl G, Stankovic N, Sterkowicz S, Del Vecchio FB, et al. (2013) Injuries in judo: a systematic literature review including suggestions for prevention. *Br J Sports Med* 47: 1139-1143.
- Bartlett R, Bussey M (2013) *Sports biomechanics: reducing injury risk and improving sports performance*. Routledge.

24. Tegner B (1977) Bruce Tegner's Complete Book of Jujitsu. Thor Publishing Company.
25. Gurgel F (2000) Manual do Jiu-jítsu-Básico.
26. Manzato ALG, Camargo HPD, Graças DD, Martinez PF, Oliveira Júnior SAD (2017) Lesões musculoesqueléticas em praticantes de judô. *Fisioterapia e Pesquisa* 24: 127-134.
27. Carpeggiani JC (2004) Lesões no jiu-jítsu: estudo em 78 atletas. Universidade Federal de Santa Catarina, Florianópolis.
28. International Brazilian Jiu-Jitsu Federation. Rules Book 2018. (5th edn), Rio de Janeiro: International Brazilian Jiu-Jitsu Federation 50
29. Timpka T, Alonso JM, Jacobsson J, Junge A, Branco P, et al. (2014) Injury and illness definitions and data collection procedures for use in epidemiological studies in Athletics (track and field): consensus statement. *Br J Sports Med* 48: 483-490.
30. Birrer RB, Halbrook SP (1988) Martial arts injuries: the results of a five year national survey. *The American Journal of Sports Medicine* 16: 408-410.
31. Del Vecchio FB, Farias CB, de Leon RC, Rocha ACCA, Galliano LM, et al. (2018) Injuries in martial arts and combat sports: Prevalence, characteristics and Mechanisms. *Science & Sports* 33: 158-163.
32. Witvrouw E, Mahieu N, Danneels L, McNair P (2004) Stretching and injury prevention. *Sports medicine* 34: 443-449.
33. McGowan CJ, Pyne DB, Thompson KG, Rattray B (2015) Warm-up strategies for sport and exercise: mechanisms and applications. *Sports Medicine* 45: 1523-1546.
34. Murray JJ, Renier CM, Ahern JJ, Elliott BA (2017) Neuromuscular training availability and efficacy in preventing anterior cruciate ligament injury in high school sports: a retrospective cohort study. *Clinical Journal of Sport Medicine* 27: 524-529.
35. Carvalho AR (2010) Utilização do treinamento neuromuscular e proprioceptivo para prevenção das lesões desportivas. *Arquivos de Ciências da Saúde da UNIPAR* 14.
36. Sadigursky D, Braid JA, De Lira DNL, Machado BAB, Carneiro RJF, et al. (2017) The FIFA 11+ injury prevention program for soccer players: a systematic review. *BMC Sports Science, Medicine and Rehabilitation* 9: 18.