



Prevalence of Upper Extremity Musculoskeletal Injuries and Symptoms in Brazilian Jiu-Jitsu Athletes

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Abstract

Introduction: Jiu-Jitsu is a martial art that originated in China and was brought to Brazil, where it became very popular and developed into a style known as Brazilian Jiu-Jitsu (BJJ). Growth in the number of BJJ practitioners has been accompanied by a consequent increase in BJJ injuries.

Objective: The aim of this study was to characterize upper-limb Musculoskeletal Injuries and Symptoms (MSISs) in BJJ athletes.

Materials and Methods: A prospective, observational cross-sectional study was conducted between January 2017 and January 2018. Male BJJ athletes with a minimum of 6 months of BJJ practice and at least a blue belt rank were enrolled. Athletes who were at the white belt level, female, or less than 18 years of age were excluded from the study. Participants completed a questionnaire that collected information about their personal characteristics and BJJ training profile, and then were subjected to a physical examination of the upper limbs. MSIS data were recorded on a spreadsheet.

Results: A total of 200 male BJJ practitioners were evaluated, of which 150 (75.0%) reported at least one upper limb MSIS. Of a total of 679 identified MSISs, 369 (54.3%) were in the hand and/or wrist, 233 (34.3%) were in the shoulder, and 77 (11.3%) were in the elbow. Logistic regression adjusted to have at least one injury indicated that greater age, years practicing BJJ, number of training hours per day, and number of trainings days per week as well as a black belt rank were significant risk factors. Notably, black belt rank increased the chances of injury by 5.57 times [95% Confidence Interval (IC): 1.13-27.58; $p=0.04$].

Conclusion: Age, years practicing BJJ, number of training hours per day and days per week, and an advanced training level are associated with upper-limb MSIS prevalence.

Keywords: Affections; Upper Extremity; Brazilian jiu-jitsu

Introduction

Jiu-jitsu is a martial art that is thought to have originated in China, though there is some controversy about its origins; it later expanded into India, Japan, and Brazil, where it was developed and enhanced into the modern Brazilian Jiu-Jitsu (BJJ) style [1]. In BJJ, athletes use technical, physical, and psychological skills to achieve victory over their opponents. Athletes use blows to try to throw their opponent to the ground where they work to neutralize, immobilize, strangle, press, and twist their opponent's joints.

In the last 20 years, interest in a martial art that provides a means of self-defense while also being a sporting activity has made BJJ very popular among young people. Concomitantly, in our clinical practice, we have observed a substantial increase in the number of martial art athletes with Musculoskeletal Injuries and Symptoms (MSIS) in the upper limbs. Injuries occur in BJJ due to direct or indirect tissue trauma and friction during BJJ practice. MSISs in BJJ athletes may be related to a number of factors, such as time spent practicing, training intensity, stroke biomechanics, fitness, and age of the practitioner [2,3]. Studies of MSISs in athletes are of great value for injury treatment and prevention. Although MSISs in martial arts have been reported previously, there is still a paucity of information regarding what occurs in the upper limbs of BJJ athletes [4-6]. To the best of our knowledge, there are no published studies about upper-limb MSISs in BJJ athletes.

Screening protocols designed to evaluate possible sports injuries provide an important means of tracking health risks that may occur while participating in exercise and sports [7]. The objective

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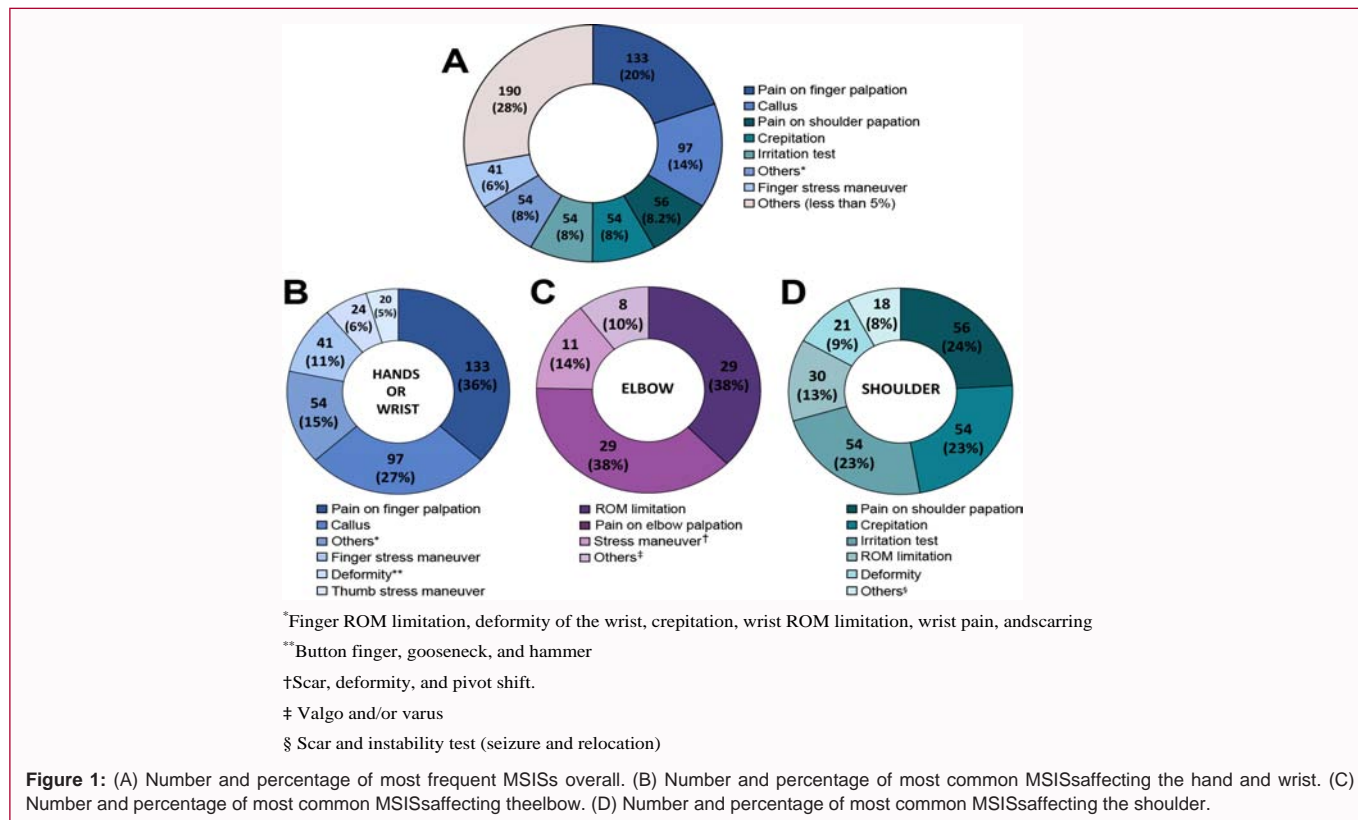


Table 1: Characteristics of study participants overall and in MSIS vs. non-MSIS.

Characteristics	Total N=200%-100%	MSIS N= 150%-75%	Non-MSIS N=50%-25%	P
Mean age ± SD, y	27.6 ± 8.3	29.1 ± 8.3	22.8 ± 6.6	<0.01
Years practicing BJJ, y	4.0 (2.0-25.0)	6.0 (3.0-31.0)	1.5 (0.3-12.0)	<0.01
Training days per week	5.0 (3.0-7.0)	5.0 (3.0-7.0)	3.0 (3.0-7.0)	<0.01
Training hours per day	2.0 (1.5-6.0)	2.0 (2.0-7.0)	1.5 (1.5-4.0)	<0.01
Dominant limb, n (%)	17 (8.5)	14 (9.3)	3 (6.0)	0.05
Belt rank, n (%)				<0.01
Blue	94 (47.0)	47 (31.3)	47 (94.0)	
Purple	40 (20.0)	38 (25.3)	2 (4.0)	
Brown	21 (10.5)	20 (13.3)	1 (2.0)	
Black	45 (22.5)	45 (30.0)	0 (0)	

Data are reported as median (IQR)

of this study was to investigate upper-limb MSISs in BJJ athletes. As a secondary objective, we analyzed whether MSISs were associated with the number of training hours per day, number of training days per week, advancement level, practice experience, dominant side, and affected side.

Methods

Participants

Informed written consent was obtained from all participants on a voluntary basis and all research was conducted in accordance with the principles set out in the Declaration of Helsinki. The study was approved by the Ethics Committee of the Federal University of São Paulo. The anonymity of the study subjects was preserved. Between January 2017 and January 2018, a prospective, observational cross-sectional study was carried out in the trauma and orthopedics departments of our institution. The inclusion criteria were: being a

BJJ athlete; having a minimum of 6 months of BJJ training; having a BJJ rank of at least a blue belt; and being male. The exclusion criteria were being a BJJ white-belt, being female, and being under 18 years of age. The term MSIS refers to any observable (sign) or athlete-reported (symptom) condition documented in an interview and upper-limb physical examination [7,8].

Data collection

The participants completed a questionnaire that collected the following data: age, advancement level, gender, side dominance, injury-affected side, BJJ training hours per day, and BJJ training days per week. Each athlete was asked if he had a prior or current upper-limb MSIS. If the athlete reported not having any MSISs, no follow-up questions were asked. When the athlete identified an upper-limb MSIS, it was checked in a physical examination protocol compiled by the authors based on findings from previous studies in athletes [9,10].

Table 2: Characteristics of participants with MSISs affecting the hand or wrist, elbow, and shoulder.

Characteristic	Total N=679-100%	Hand or wrist N=369-54.3%	Elbow N=77-11.3%	Shoulder N=233-34.3%	P
Age, y'	29 (23-37)	28 (23-37)	32 (23-43)	30 (22-37)	0.04
Years practicing'	8 (3.0-17.0)	6.0 (3.0-16.0)	9.0 (3.0-22.0)	7 (3.0-18.0)	<0.01
Training days per week'	6.0 (3.0-5.0)	3.0 (5.0-6.0)	5.0 (3.0-6.0)	5.0 (3.0-7.0)	0.04
Training hours per day'	2.4 (2.0-5.0)	2.0 (2.0-4.0)	2.0 (2.0-5.0)	2.3 (2.0-6.0)	0.08
Belt rank, n (%)					<0.01
Blue	173 (25.5)	100 (27.1)	17 (22.1)	56 (24.0)	
Brown	85 (12.5)	45 (12.2)	11 (14.3)	29 (12.4)	
Purple	152 (22.4)	83 (22.5)	15 (19.5)	54 (23.2)	
Black	269 (39.6)	141 (38.2)	34 (44.2)	94 (40.3)	

Data are reported as median (IQR)

Table 3: Binary logistic regression of participant and training characteristics adjusted to have at least one injury.

Characteristic	Odds ratio unadjusted (95% CI)	P	Odds ratio adjusted (95% CI)	P
Age, y	1.13(1.05-1.21)	<0.01	1.09 (1.02-1.16)	0.01
Years practicing	1.65 (1.36-1.99)	<0.01	1.32 (1.09-1.60)	<0.01
Training hours per day	1.89 (1.44-2.48)	<0.01	1.51 (1.03-2.21)	0.03
Training days per week	4.44 (2.14-8.82)	<0.01	2.74 (1.32-5.69)	0.01
Black Belt	8.1 (1.89-35.11)	<0.01	5.57 (1.13-27.58)	0.04

Data are reported as median (IQR)

The physical examination performed consisted of assessments of the hand and wrist, elbow, and shoulder with respect to evidence of a deformity, increased volume, scars, skin abnormalities, pain upon palpation, the presence of crackling in a joint, and Range of Motion (ROM) limitations. Special tests were performed for each limb segments.

For the hand, finger stress tests were performed. For the wrist, Watson's scapho-lunate and distal radioulnar joint instability tests were performed. For the elbow, the varus stress test and pivot shift maneuver were performed [11]. Finally, for evaluation of the shoulder, the participants were submitted to instability (seizure and relocation) and irritative (Neer, Hawkins, and Jobe) tests [11].

Statistical analysis

Study sample size calculated using proportions in a population of 1000, considering an approximate 65% prevalence of upper limb conditions [9] and a 95% Confidence Interval (CI), indicated that a sample size of 198 participants would be appropriate. Appropriate sample size was calculated in Open Epi, version 3.01 software [12].

Categorical data are presented as proportions. Non-parametric continuous data are reported as medians with Interquartile Ranges (IQRs). Parametric data are reported as means with Standard Deviation (SDs). Fisher's and Chi-square tests were used to compare categorical variables between the study groups. Continuous variables were analyzed with the Mann-Whitney U test. A p value <0.05 was considered statistically significant. A multivariate regression analysis was performed, with adjustment to have at least one MSIS; variables with a p<0.2 result in the univariate analysis were included in the final model. The data were subjected to statistical analysis in IBM SPSS Statistics for Windows software version 24.0.

Results

Characteristics of the participants and MSIS presentation

A cohort of 200 male BJJ practitioners with a mean age of 27.6 ± 8.6 years (range, 18 years to 54 years) participated in this study. Of

the 200 BJJ athletes evaluated, 150 (75.0%) reported having a MSIS (MSIS group) and 50 (25%) did not (non-MSIS group). Age was significantly higher in the MSIS group (29.1 years, SD 8.3) than in the non-MSIS group (22.8 years, SD 6.6; p ≤ 0.01). Years practicing BJJ, the number of hours of training per day, and the number of training days per week were significantly higher among the MSIS group than in the non-MSIS group (Table 1). With respect to advancement rank, almost a third of the MSIS groups were blue belts (47/150, 31.3%) and almost a third was black belts (45/150, 30%). Meanwhile, the vast majority (47/50, 94%) of athletes in the non-MSIS group had a blue belt rank (Table 1).

Distribution of MSISs

The 200 participants in the study had a total of 679 MSISs, with hand and wrist conditions (369/679, 54.3%) being the most prevalent (Figure 1A), followed by shoulder conditions (233/679, 34.3%) and elbow conditions (77/679, 11.3%). The most common hand and wrist MSISs were finger palpation pain (133/679, 36%) followed by the presence of calluses (97/679, 27%). Relatively infrequent MSISs included finger stress maneuver pain, finger deformity, and thumb stress (Figure 1B). As shown in Figure 1C, the most common elbow MSISs affecting BJJ athletes were ROM limitations (29/150 participants, 38%) and palpation pain (29/150 participants, 38%), followed by stress maneuver (scar, deformity, and pivot shift) positivity (11/150 participants, 14%). As shown in Figure 1D, the most common shoulder MSISs affecting athletes were pain on palpation (56/150 participants, 24%), joint crackling (54/150 participants, 23%), irritative test positivity (54/150 participants, 23%), ROM limitation (30/150 participants, 13%), and deformity (21/150 participants, 9%).

The median age of athletes with a MSIS was 29 years (IQR, 23-37). With respect to MSIS site, median age [32 years (IQR, 23-43); p=0.04] and years spent practicing BJJ [9 years (IQR, 3.0-22.0); p<0.01] were highest in participants with elbow MSISs. BJJ black belt athletes were most likely to have upper-limb MSISs compared to athletes at other (lower) ranks (p<0.01) (Table 2).

Table 4: Characteristics of participants with at least five versus four or fewer MSISs.

Characteristic	MSIS ≥ 5 N=80 (53.3%)	MSIS <5 N=70 (46.7%)	P
Age, y`	30 (22-39)	26 (22-35)	0.02
Practice time, y`	7.0 (3.0-19.0)	6.0 (2.0-12.0)	0.02
Training days per week`	5.0 (3.0-7.0)	5.0 (3.0-7.0)	0.08
Training hours per day`	2.5 (2.0-5.6)	2.0 (1.5-4.0)	0.02
Beltrank, n (%)			0.04
Blue	22 (27.5)	25 (35.2)	
Purple	16 (20.0)	22 (31.0)	
Brown	8 (10.0)	13 (18.3)	
Black	34 (42.5)	11 (15.5)	



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PREVALÊNCIA DAS AFECÇÕES NOS MEMBROS SUPERIORES EM ATLETAS DE JIU-JITSU BRASILEIRO

Identificação:

Nome _____

Idade _____ Gênero _____

Tempo de prática _____ Nº de horas por dia _____

Nº dias semana _____ Graduação _____

Lado dominante _____ Lado acometido _____

Você tem ou teve afecção em MMSS durante a prática de jiu-jitsu brasileiro?

() Não

() Sim () Mão e/ou punho () Cotovelo () Ombro

Exame Físico mão e punho

() Deformidades () aumento de volume () alterações da pele () Dor a palpação () Crepitação () Limitação da amplitude de movimento () Stress de dedos () Cicatriz

Exame Físico Cotovelo

() Deformidades () aumento de volume () Dor a palpação () Crepitação

() Limitação da amplitude de movimento () Stress varo () Stress valgo () Pivot Shift () Cicatriz

Exame Físico Ombro

() Deformidades () aumento de volume () Dor a palpação () Crepitação

() Limitação da amplitude de movimento () Cicatriz

() Apreensão () Relocação

() Neer () Hawkins () Jobe

Protocol:

Binary logistic regression (adjusted to have at least one MSIS) revealed that a more advanced age, a greater training time in years, a greater number of training hours per day, a greater number of training days per week, and black belt status were significant risk factors for MSISs. As reported in detail in Table 3, black belt BJJ athletes had a 5.57 times greater risk of a MSIS than lower ranked athletes (95% CI, 1.13-27.58; p=0.04). Meanwhile, training every day of the week increased MSIS risk by 2.74 times (95% CI, 1.32-5.69; p=0.01). Relative to athletes with four or fewer MSISs, athletes with at least five MSISs tended to be significantly older, to have spent significantly more years training BJJ, and to spend significantly more hours per

day training (Table 4). With respect to rank, black belt athletes were significantly more likely than the color belt subgroups to have at least five MSISs (Table 4).

Discussion

Although most injuries affecting BJJ practitioners affect the upper limbs [13,14], no prior study has focused on the characteristics of MSISs affecting the hand or wrist, elbow, and shoulder. Research into other martial art styles, including karate, judo, and mixed martial arts [3,4,15], have tended to report MSISs in the whole body without focusing on specific locations. The cross-sectional design used for

this study was modeled after that used in prior studies [1,16] to obtain an understanding of upper-limb MSIS characteristics in BJJ practitioners.

Those participants who presented MSISs in our study had a higher mean age, similar to other studies [6,13], consistent with the notion that increasing age and more years of practice increase MSIS risk [17]. The training time in years of the present cohort of BJJ athletes was similar to that reported in a prior study of BJJ athletes [13]. Concomitantly, we found that those athletes who had MSISs tended to have more years of practice than the non-MSIS group. Hence, there appears to be a direct relationship between BJJ training history duration and musculoskeletal injuries [18]. Likewise, we found that both hours spent training per day and training days per week were related to MSIS occurrence, in accordance with previous findings [19-22]. In our study, there was a significant difference in MSIS occurrence and BJJ rank. Participants who had been promoted to a black belt rank tended to have more MSISs than lower ranked athletes, consistent with prior findings [18]. MSIS rates were similar among lower-rank color (blue, purple, and brown) belt athletes. With respect to MSIS location, we observed the greatest number in the hand or wrist, followed by the shoulder, with relatively few MSISs affecting the elbow, consistent with previous studies [6,13,15].

Jiu-Jitsu involves six types of techniques

Projections, immobilizations, pincers, holds, twists, and bottle necks. Use of the hands, elbows, and shoulders is indispensable in the execution of these techniques [23]. It is possible to formulate hypotheses about MSIS findings in BJJ athletes that take into consideration joint biomechanics [24]. Biomechanically, the hand allows highly precise actions [25]. Specifically, the fingers produce so-called "footprints" in BJJ, which are self-made and opposing pincers with isometric strength [26]. The performance of such techniques puts the hands and wrists at risk, which may explain our finding of highly prevalent MSISs affecting the hands or wrists. The direct contact intended to bring one's opponent to the ground accompanied by high-speed impacts in BJJ [2] may underlie MSISs of the shoulder, which is formed by four separate joints and a complex of muscles and ligaments [27].

Technically, BJJ attacks consist predominantly of holds that control joint structures by way of direct immobilization and extension beyond the normal ROM. The most common holds are those that hyperextend the elbow and knee joints. However, the relative complexity of their execution relative to hand and shoulder techniques, among other factors, may limit the number of MSISs affecting the elbow.

Prior multivariate analyses have examined various factors that may influence bodily injuries during Jiu-jitsu practice [28,29]. Here, our analysis, which was focused on the participants' training characteristics, indicated that a black belt rank and frequent training were important MSIS risk determining factors, consistent with data that considered anthropometric data [4]. When we divided the BJJ athletes with upper-limb MSISs into groups with at least five versus less than five MSISs, we observed additional associations of MSIS occurrence, including MSIS associations with age, years of training, and number of hours of training per day, in addition to black belt rank.

This study had limitations related to the study design. A memory bias of athletes may have affected their reporting of MSISs and MSIS

characteristics and there was a lack of information in the participants medical records with respect to MSIS occurrence, injury severity, and technique types used. Future studies should specify the degrees of severity, techniques being used at the time of MSIS occurrence, sequela, and MSIS treatment parameters. Our results support the notion that knowledge of MSIS risk factors have predictive value for injuries in BJJ [30,31].

Conclusion

Age, BJJ practice time, number of training hours per day, number of training days per week, and rank were found to be associated with prevalence of hand or wrist, elbow, and shoulder MSISs.

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