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original research

Incidence of Injury Among Male Brazilian Jiujitsu Fighters at the World Jiu-Jitsu No-Gi Championship 2009

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Context: Brazilian jiujitsu is a modern combat martial art that uses joint locks to submit an opponent and achieve victory. This form of martial art is a relatively young but rapidly growing combat sport worldwide.

Objective: To determine the cumulative injury incidence and risk of injury by belt rank and body region at an international-level Brazilian jiujitsu tournament.

Design: Descriptive epidemiology study.

Setting: World Jiu-Jitsu No-Gi Championship 2009 in Long Beach, California.

Patients or Other Participants: We monitored 951 athletes (age range, 18–50 years) enrolled to compete in the World Jiu-Jitsu No-Gi Championship 2009.

Intervention(s): Fighters were categorized by belt level for group comparisons (belt experience). Incidence rates per 1000 athlete-exposures (AEs) and incidence rate ratios were compared by belt rank.

Main Outcome Measure(s): Incidence rates and incidence rate ratios.

Results: During the tournament, 1606 AEs and 62 total injuries were reported. Of these injuries, 40 affected the joints, for an overall incidence rate of 24.9 per 1000 AEs. The joint incidence rate by belt rank was 21.5 per 1000 AEs for blue, 21.3 per 1000 AEs for purple, 25.2 per 1000 AEs for brown, and 35.1 per 1000 AEs for black. We found no differences for incidence rate ratios of joint injury among individual belt groups ($P > .05$). More experienced (brown belt and black belt) competitors had a higher injury risk than the less experienced (blue belt and purple belt) competitors; however, the difference was not significant (incidence rate ratio = 1.65, 95% confidence interval = 0.9, 2.9; $P = .06$). The incidence of joint injury was highest at the knee (7.5 per 1000 AEs) and elbow (7.5 per 1000 AEs).

Conclusions: The data from this international Brazilian jiujitsu tournament indicated that the risk of joint injury was similar among belt ranks or experience during this Brazilian jiujitsu competition. The knee and elbow were the joints most susceptible to injury. Future investigation of injury mechanism is warranted to develop strategies to reduce potential risk factors attributed to injury.

Key Words: mixed martial arts, combat sports, collegiate wrestling

Key Points

- Total injury rates were similar in joint location and frequency among fighters of various belt rank.
- Fighters at more experienced levels showed a trend toward having higher risks of injury.
- Injury rates were higher for the knee and elbow than for the shoulder and elbow joints.
- More-skilled fighters had a greater risk of injury in the championship matches.

Brazilian jiujitsu (BJJ) is a modern combat martial art that uses joint locks during competition to submit an opponent and achieve match victory.[1,2] Similar-style sports that include person-to-person combat are collegiate wrestling and judo. Whereas collegiate wrestling does not include joint locks to subdue an opponent or attain final success, it does include similar movements and body-to-body holds.

The sport of BJJ is a gateway for mixed martial arts (MMA), which is a relatively young but popular combat sport worldwide.[3–5] Brazilian jiujitsu fighting consists of 1 continuous round that is 5 to 10 minutes long. The ages and belt ranks of fighters depend on the length of their fights. A fight ends when (1) a fighter "taps out" (ie, referee stoppage due to an opponent tapping on the mat or the opponent during a submission lock [terminal joint end range]) or (2) a point differential exists at the end of the match period.

Since its inauguration in the United States in 1990, BJJ has quickly gained popularity in this country, with a consistent 100% annual increase in online interest.[6,7] Brazilian jiujitsu tournaments are growing rapidly worldwide, with thousands participating each year.[8] The number of athletes registering at annual BJJ championship events has increased markedly since its introduction in the United

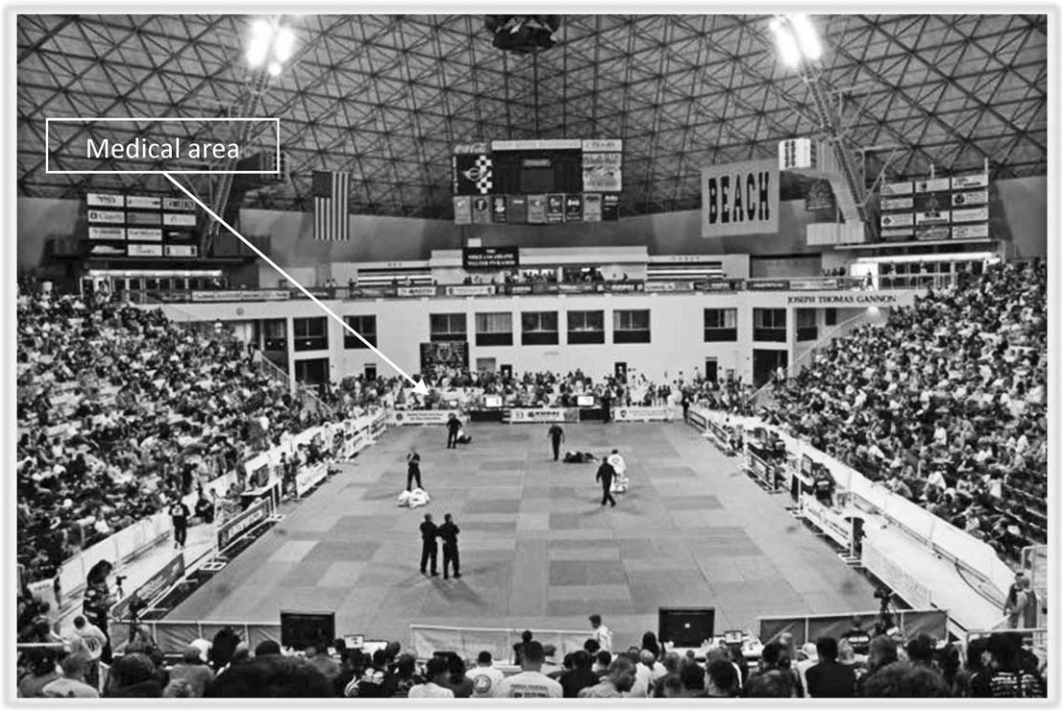

Figure 1. Competition area and location of medical tent area.

States.[8] The first World Jiu-Jitsu Championship in the United States was held in California in 2007 and had a participant enrollment of 1770 competitors.[8] In 2013, this event has increased to 2300 total competitors.[8] With this increased participation, the number of competitors at risk for injury also has likely increased. However, given its relatively new infrastructure, no reports of injury incidence data have been available for BJJ or MMA. Whereas BJJ has gained international attention in the martial arts community, little is known about injury in this sport.[3,4] Brazilian jiujitsu may provide a preview of joint injury patterns expected in future BJJ and MMA competitions.

Empirical evidence from the medical team of the primary author (E.M.K.) at BJJ international tournaments over the past 10 years has generated assumptions that athletes of lower belt rank would lack the skill set to acknowledge joint end-range position during BJJ activity and, thus, their injury risk would be greater than for those with higher belt ranks. In addition, our observations also have produced the corollary hypothesis that the joints of the long bones (knee and elbow) would be the most susceptible to joint-lock injury. Therefore, the purpose of our study was to determine the cumulative injury incidence and the risk of injury by belt rank and body region during the World Jiu-Jitsu No-Gi Championship 2009.

METHODS

Participants

The World Jiu-Jitsu No-Gi Championship 2009 was held in Long Beach, California. Participant enrollment included a convenience sample of 951 male fighters aged 18 to 50 years. All fighters were eligible and were followed in the study. The belt rank of BJJ fighters consisted of blue (least skill-experienced), purple, brown, and black belt (most skill-experienced) levels. Chart data were collected retrospectively, and the Institutional Review Board of Concordia University, Irvine, California, approved this study.

Data Collection

Injuries. The tournament director instructed all BJJ fighters who sustained injuries during the tournament to seek medical assessment and clearance from a certified athletic trainer at the medical area (Figure 1). *Injury* was defined as a situation in which the fighter either requested medical treatment or was unable to continue a contest due to pain or discomfort. The final diagnosis of the injury was triangulated among a certified athletic trainer, physical therapist, and medical doctor for assessment. In addition, any fighter who sustained an injury that was evaluated on the mat area by the certified athletic trainer was evaluated further in the medical area. The proximal location of the medical area to the competition mats ensured high accuracy for capturing each injury sustained during the tournament (Figure 1). Data that met the inclusion criteria were categorized by joint (shoulder, elbow, knee, or ankle) and aggregated. Given that BJJ focuses on submission joint locks to subdue an opponent to achieve match victory, other reported injuries, such as back, rib, and skin injuries, also were recorded but were not included in the musculoskeletal joint analysis.

Study Questionnaire. At the medical tent of the tournament, the certified athletic trainers used a specially designed questionnaire to record each fighter's sex, age, mass, belt level, years of experience in BJJ, number of training days per week, and number of matches in the tournament.

Table 1. Distribution of Injuries per 1000 Athlete-Exposures[a] (N = 1606) by Belt Level and Body Part

Belt Level	Body Part Injured, n					
	Shoulder	Elbow	Knee	Ankle	Other	Total
Blue	5	5	3	1	7	21
Purple	0	2	5	1	3	11
Brown	0	1	2	3	6	12
Black	5	4	2	3	4	18
Total	10	12	12	8	20	62
Percentage[a]	16.1	19.4	19.4	12.9	32.3	100
Incidence rate[b]	5.0	7.5	7.5	5.0	11.2	36.1

[a] Percentages were rounded.
[b] Indicates rate per 1000 athlete-exposures.

Athlete-Exposure. An athlete-exposure (AE) was calculated as any match in which a BJJ fighter was at risk of sustaining an injury. The total number of AEs was determined by multiplying the cumulative number of matches by 2 because 2 competitors were involved in each match.[6] This method of determining total AEs has been used in previous studies concerning injuries in athletic competitions.[1,9–11]

Statistical Analysis

The *incidence rate* was defined as the number of injuries per 1000 AEs. Fighters were categorized into belt graduation levels for group comparisons (belt rank progression level: blue, purple, brown, and black). Incidence rate ratios and 95% confidence intervals were calculated to determine differences among sex, belt rank, injury type, and body region or part. The α level was set at .05. All analyses were conducted with STATA (version 5.0; STATA Corp, College Station, TX).

RESULTS

Injury data by body part and belt are presented in Tables 1 and 2, respectively. Of the 951 BJJ fighters who competed during the tournament, 62 injuries (62 athletes) and 1606 AEs were reported, for an overall incidence rate of 38.6 injuries per 1000 AEs. The injured fighters had a mean age of 29.4 ± 5.7 years, height of 69.4 ± 5.7 cm, and mass of 173.7 ± 5.6 lb (78.8 ± 2.5 kg). A total of 40 of the 62 injuries affected the joints, for an incidence rate of 24.9 injuries per 1000 AEs. Other injuries included lacerations, epistaxis, rib pain, and skin abrasions. The incidence rate of joint injury was highest at the elbow and knee (both 7.5 injuries per 1000 AEs). Comparatively, incidence rates at the shoulder and ankle were 5.0 injuries per 1000 AEs. The incidence rate for joint injuries for each belt rank was 21.5 injuries per 1000 AEs for blue, 21.3 injuries per 1000 AEs for purple, 25.2 injuries per 1000 AEs for brown, and 35.1 injuries per 1000 AEs for black (Figure 2). No differences were found for incidence rate ratios of joint injury among individual belt groups ($P > .05$). In addition, the more skill-experienced (brown belt and black belt) fighters had a higher injury risk than the less skill-experienced (blue belt and purple belt) fighters, but the finding was not significantly different (incidence rate ratio = 1.65, 95% confidence interval = 0.9, 2.9; $P = .06$). Injuries by location for each belt rank are presented in Figure 3. Percentages of other injuries accounting for the total injury count of each belt rank were 33.3% (n = 7) for blue belt, 27.3% (n = 3) for purple belt, 50% (n = 6) for brown belt, and 22.2% (n = 4) for black belt.

DISCUSSION

To our knowledge, we provide one of the first large-scale epidemiologic reports describing the risk of injury in BJJ. The elbow and knee had the highest incidences of joint injury. Whereas the more skilled fighters (brown and black belts) had a greater risk of injury in this tournament, few differences were found between fighter experience or skill level and location of joint injury.

Our findings are consistent with those reported in similar sports, such as collegiate wrestling, in which the more experienced wrestlers had higher frequencies of injury than their less experienced counterparts.[1,12,13] Researchers[14] have reported injury incidences and rates that were lower for high school than collegiate wrestlers. Comparably, these data have suggested higher injury rates for more experienced wrestlers and a higher incidence of injury by joint location.

Investigators have indicated the incidence of upper extremity injuries in high school wrestlers was higher[1,9,15] than the incidence of lower extremity injuries in collegiate wrestlers.[1] These contrasting data are similar to those for the BJJ fighters in our report. The incidence of injury to the lower extremities also was greater in the more-experienced college-aged wrestlers.[1,13] Our assumption was that more experience would be related to a reduction in injury risk. However, our data analysis did not support this assumption, as the risk of joint injury was similar for belt ranks or experience levels during tournament competition.

Takedown maneuvers are the most common mechanisms of injury in high school and collegiate wrestling.[9] Pasque and Hewett[9] hypothesized that the takedown is a dangerous maneuver due to the defensive nature of the position. Although we did not capture data on injury mechanism, the lack of differences among belt levels or rank may suggest that mechanisms of injury are related more to inherent technique than skill in performing submission wrestling maneuvers. These data suggest that it may be possible to

Table 2. Distribution of Total Injured by Belt Level and Enrollment

Belt Level	Enrolled, n	Total Injured, n	Percentage Injured
Blue	368	21	5.7
Purple	222	11	5.0
Brown	144	12	8.3
Black	217	18	8.3
Total	951	62	6.5

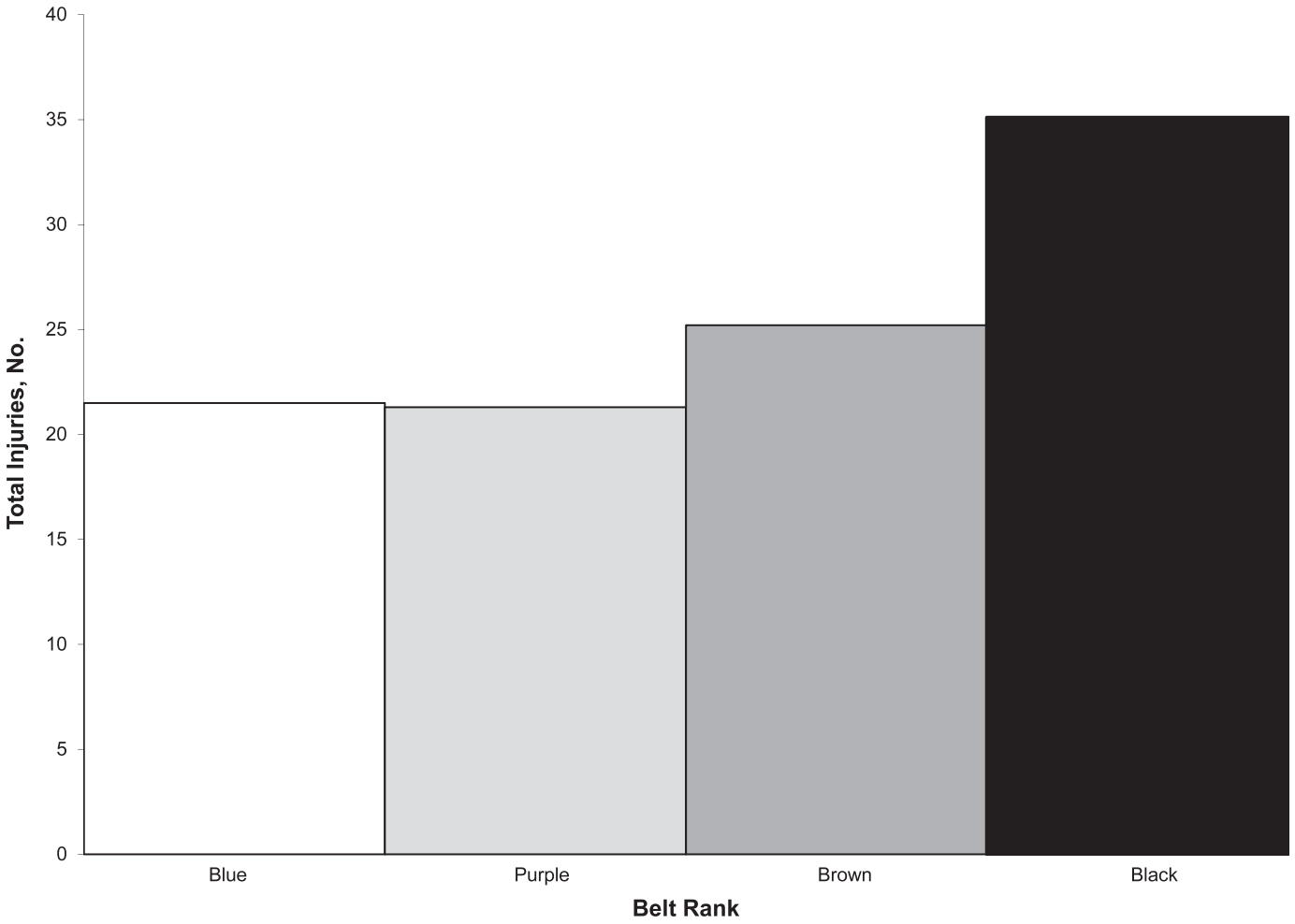

Figure 2. Reported injuries for each belt rank among Brazilian jiujitsu fighters during the World Jiu-Jitsu No-Gi Championship 2009.

reduce the chance of injury by increasing awareness by and further educating referees, athletes, and mentors and instructors (the latter 2 in particular with respect to defensive-position coaching).[9] In future studies of injury incidence in BJJ, researchers ought to include mechanisms of injury to support the development of detailed injury-prevention programs.

Yard et al[13] indicated that injuries were common at both the high school and collegiate levels of wrestling competition, but the rate of injury increased for the more experienced wrestlers. Collegiate wrestlers sustained higher injury rates and more severe injuries as competition experience levels increased. In addition, injury rates were 3 times higher in collegiate than high school wrestlers.[13]

Injury data for athletes in combat sports similar to BJJ, such as judo, have indicated an increased frequency of injuries in the upper extremities.[6,16,17] Injuries in judo-style competition occur most often from grip fighting, being thrown, or attempting to throw an athlete.[16,18–20] These outcomes are in contrast to data collected for BJJ fighters.

Although both BJJ and judo are combative sports, data suggesting cervical injury is prevalent in competition are limited.[16–18,20,21] Concurrently, researchers[1,15,22,23] have reported that collegiate athletes in wrestling competitions and practice sessions experienced fewer cervical injuries than overall extremity injuries. Whereas wrestling-style arts and judo share features with MMA, the former do not include deliberate striking during practice and competitions, as MMA-style competition does. This dichotomy may lead to increased rates of facial and head injuries in MMA competitions.[2–5,24,25]

A stark difference between collegiate wresting and BJJ grappling is the ability of BJJ fighters to submit opponents via a joint neck choke or joint lock (ie, taking a joint to its terminal end range to finish a match). Collegiate wrestling rules do not allow such joint locks to subdue an opponent. As noted, we did not collect data about the mechanism of injury during this study; however, during our medical staff coverage of BJJ over the past 10 years, we consistently have observed that joint location of injury and its applied joint locks reflect terminal end range of the applied lock. During this study, BJJ injuries were reported as athletes requesting medical treatment or being unable to continue a contest due to pain or discomfort.

Although in its infancy in the United States, BJJ is similar to collegiate wrestling because the participants have similar injury rates and locations of injury when compared by skill level. We postulate that higher-level fighters may have increased injury rates because rules allow competitors at the brown belt and black belt levels (but not at the blue belt and purple belt levels) to attack the lower extremities. Concomitantly, more-experienced fighters may attempt to withstand the potential submission hold due to their experience levels and knowledge of the position. However,

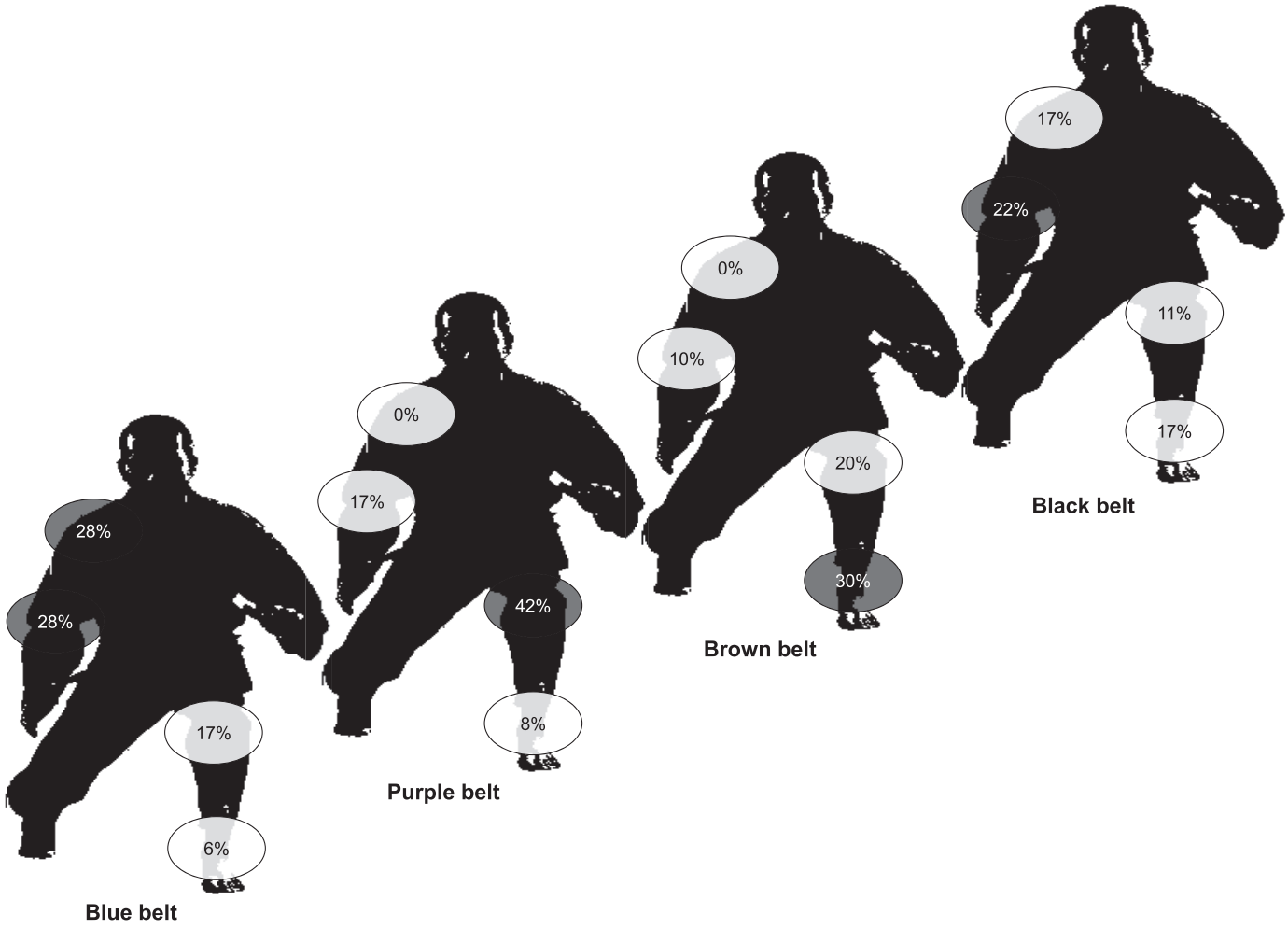

Figure 3. Relative injuries by location for each belt rank. For each belt rank's total injury count, other injuries accounted for 33.3% (n = 7) of blue belt, 27.3% (n = 3) of purple belt, 50% (n = 6) of brown belt, and 22.2% (n = 4) of black belt injuries.

given that no data have been reported on these characteristics, future studies are recommended to elucidate these experience factors and rates of injury.

To our knowledge, we are the first to study the musculoskeletal joint injuries at a large BJJ-style championship event. These large events have increased markedly in frequency and location throughout the United States in the past decade.[8] Thus, the understanding of BJJ and its potential injuries is warranted as the sport continues to grow. Additional strengths of our study are the prospective research design and the medical team's combined 27 years of experience covering the sport of BJJ and observing injuries in its competitors.

Our study had some limitations. First, the definition of *injury* may vary by study. Our definition reflected any athlete who requested medical treatment during the tournament or who could not continue due to pain or discomfort. Second, whereas the injury mechanism may be synonymous with terminal joint end range, data were not recorded due to multiple possible injury mechanisms. Other researchers[1,13] have discussed injuries as resulting in time missed from participation after a practice or event. In this study, we were unable to capture all injuries resulting in time missed from participation after an event for several reasons.[1] Self-reporting of injuries during the tournament was voluntary. Our medical staff, event referees, and others did their best to identify all competitors perceived to have incurred injuries and recommend that they report to the medical tent during the event; however, it is possible that some athletes still decided not to report their injuries. Last, data for this event were collected only for athletes known to be injured during the competition. A small possibility exists that injuries to joints were not reported to the medical area; however, the proximity of the medical area to competition helped ensure that most reportable joint injuries were captured.

CONCLUSIONS

The total injury rates for the World Jiu-Jitsu No-Gi Championship 2009 were similar in joint location and frequency to rates for National Collegiate Athletic Association wrestlers. We found a trend toward athletes at more experienced levels having higher risks of injury. Although speculative, assumptions for increased injury rates at higher belt levels may have been due to a difference in rules among the levels. Last, the elbow and knee joints had higher injury rates than the shoulder and ankle joints.

Based on limited published studies, to our knowledge, no data about the injury incidence in BJJ have been reported. Future research is warranted to determine mechanisms of

injury and risk factors in BJJ. Investigators should focus on mapping specific injury patterns. As the number of BJJ competitions continues to increase worldwide, a better understanding of injury frequency and type should be of primary concern. Based on the injury rates and severities we observed, we highly recommend efforts to include qualified sports medicine personnel at all BJJ events for improved prevention, recognition, and treatment of injuries.

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