An Evidenced-Based Training Plan for Brazilian Jiu-Jitsu

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ABSTRACT

BRAZILIAN JIU-JITSU (BJJ) IS A GRAPPLING-BASED COMBAT SPORT, WHICH HAS GROWN CONSIDERABLY IN POPULARITY IN RECENT YEARS. DESPITE THIS INCREASED INTEREST, THERE ARE NO PROPOSED TRAINING STRATEGIES BASED ON PRIMARY PHYSIOLOGICAL DATA GATHERED FROM BJJ ATHLETES. PRESENTED HERE IS A DETAILED PERIODIZED TRAINING PLAN FOR BOTH THE ELITE AND SUBELITE BJJ COMPETITOR, WHICH DRAWS UPON PRIMARY RESEARCH INTO THE SPORT. THIS STRATEGY CONSIDERS THE EFFECTIVE PAIRING OF PHYSIOLOGICALLY COMPATIBLE TRAINING MODALITIES, IN ADDITION TO THE DESIGN OF ENERGY SYSTEM-SPECIFIC CONDITIONING TASKS. ALSO DISCUSSED ARE METHODS FOR MANAGING THE TRAINING LOAD TO ENSURE OPTIMAL PERFORMANCE FOR COMPETITION.

INTRODUCTION

Brazilian jiu-jitsu (BJJ) is a grappling-based combat sport that was derived from judo (4) in the early 20th century (23). Its original design was as a system for self-defense, whereby many strength-dependent strategies of judo were replaced with more technical maneuvers utilizing leverage and minimal energy expenditure (4). It is well documented that BJJ fighters found success in early no-holds-barred competitions through the effectiveness of these efficient techniques and in their ability to fight a single bout for extended durations, in some cases to hours in length (48). Accordingly, this martial art is regarded as one of the key disciplines of mixed martial arts (MMA) and has risen to prominence in recent years alongside the growth of MMA. Although inherently a self-defense system, structured BJJ competitions have increased in popularity and professionalism over the past 15 years (27), with elite international and numerous regional events available to the BJJ competitor. Additionally, many international grappling events offer lucrative prizes to higher-level competitors. The shift from self-defense to sport, whereby time limits and points govern victory, has increased the reliance on the physical capacities that were once only a minimal component of BJJ. As such, there is now an increased demand for evidenced-based strength and conditioning methods to provide competitors with a physical advantage. However, despite discussions on strength and conditioning methods for BJJ in the literature (29), none have drawn upon physiological data from the sport to underpin their recommendations. Furthermore, still to be discussed is a detailed periodization strategy to effectively manage training load and integrate training tasks to minimize both interference effects and overtraining potential. The purpose of this article is to review the primary literature on the physiological demands of BJJ, and develop a detailed, evidenced-based training plan based on these data.

BRAZILIAN JIU-JITSU

BJJ is characterized by work periods containing lengthy groundwork sequences (145 seconds) with only a small amount of time spent executing standing combat (25 seconds) (14). Competition is commonly a tournament structure, with the minimum between-match rest period equal to the regulation match duration for each respective division. Final matches receive double this duration for recovery (26). Time limits are dictated by ranking, ranging from 5 minutes for white belts to 10 minutes for black belts (Table 1). Bouts may be won during this time through an application of a joint lock or strangulation technique causing an opponent to submit and therefore end the match. Additionally, points are awarded based upon advancement to a more dominant position; these points are used to determine a winner should the bout last the duration.

AEROBIC AND ANAEROBIC CAPACITY

In addition to considering bout duration, assessing the time-motion characteristics of a BJJ match can assist in accurately determining the aerobic and anaerobic contributions. It has been reported that a 10:1 (14) and 6:1 (2) work

KEY WORDS:
combat sports; periodization; concurrent training; interval training; strength and power development

Table 1 Bout duration for each rank	
Rank	**Bout duration**
White belt	5 min
Blue belt	6 min
Purple belt	7 min
Brown belt	8 min
Black belt	10 min

to rest ratio is applied during regional level BJJ bouts. This is represented by only 13 seconds of rest dividing the aforementioned 170-second periods of action. Similarly, Andreato et al. (2) observed 117 seconds of work followed by 20 seconds of pause (Figure 1). Due to the paucity of data on BJJ, other grappling sports have been used to guide BJJ training interventions (29). However, BJJ action sequences are considerably longer than that of judo and wrestling, which contain work periods of approximately 30 seconds (32) and 37 seconds (37), respectively, for a work to rest ratio of only 3:1. Thus, despite mechanical and contractile similarities, these sports may not provide an accurate indication of energy system contribution in BJJ and, therefore, should not be relied on to guide physiologically specific energy system conditioning.

These extended periods of effort followed by brief periods of rest over a 5- to –10-minute match suggest contributions from both aerobic and anaerobic metabolism, with greater aerobic supply as the athlete's ranking (and thus bout duration) increases (8,22). However, these work periods contain intervals of low- and high-intensity effort (2), leading to both moderate (2) and high (13) blood lactate levels in response to 5-minute BJJ competition and 10-minute simulated competition, respectively. Thus, notable contributions from fast glycolysis are also present (22).

STRENGTH

Although high levels of upper-body strength endurance have been observed in elite BJJ athletes (46), no data exist on the maximal strength levels of these competitors. Despite differences in energy system contributions, the mechanical similarities between BJJ and other sports with grappling demands can provide insight into the importance of maximal force production to BJJ performance. Although isometric actions predominate grappling-based combat sports, increased levels of maximal dynamic strength are characteristic of these athletes. High values of this quality are present in elite level wrestlers (20,49), whereas in rugby league, where player-to-player contact and grappling activity is frequent, maximal strength is a key indicator of playing level (5,6). Front row forwards in rugby union, who experience higher contact and grappling demands than loose forwards, also produce greater force during scrummaging (42).

In addition to maximal strength being a potential marker of performance for these athletes, it also positively impacts other physiological capacities. Increases in this quality allow for superior adaptations to power training (11), enhances endurance performance, (1,39) and improves resiliency to injury (31). Taken together, this suggests that strength is an important training factor for the BJJ competitor.

POWER

Power is defined as work done per unit of time and as a function of force multiplied by velocity (36). As such, this quality is characterized by brief, high-intensity periods of action. During a BJJ bout, each 117-second block of work contains four 3- to 5-second expressions of high-intensity effort, followed by 25 seconds of lower-intensity work (2) (Figure 1). This represents a high intensity to lower intensity (Hi:Lo) ratio of approximately 1:5 for each 117-second work period. Fueling these high-intensity expressions is the ATP-PC system (22). It is important to consider that decisive moments of a match typically require these expressions of power (2). This may include the application of a submission or a maneuver to achieve a more advantageous position. Thus, while the ATP-PC system may not be the primary contributor to energy supply during a BJJ bout, when it is applied, the outcome represents a crucial moment of the match.

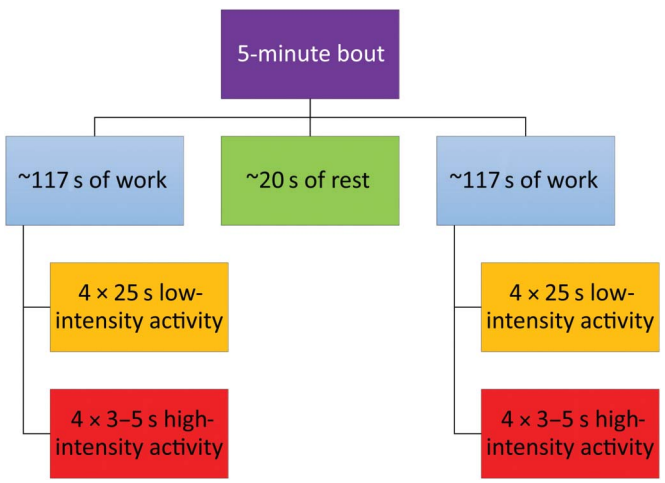

Figure 1. Time-motion breakdown from a collection of 5-minute competitive Brazilian jiu-jitsu bouts. Figure created based on data from Andreato et al. (2).

THE TRAINING PLAN FOR A BRAZILIAN JIU-JITSU COMPETITOR

PERIODIZATION

Periodization is a set of principles used to manage the stressors of training, ultimately allowing an athlete to peak at predetermined points throughout a training plan (8). Accordingly, the BJJ athlete should select and prioritize their competitive events in advance.

A mesocycle can then be dedicated to the preparation for a selected tournament. The duration of this cycle will depend on the frequency and level of competition. For example, a novice competitor may compete more frequently, participating in the numerous regional tournaments that are often scheduled, whereas at the elite, black belt level, athletes might only compete 2 or 3 times per year. Once the events are selected, the training load can then be manipulated to ensure appropriate management of stimulus and fatigue.

Structure of the plan. It has been reported that a sequenced periodization structure results in superior performance gains in athletes undertaking concurrent training (18,40) and is suggested to be the optimal design for combat sport competitors (28). As such, the mesocycle will be divided into 3 smaller training blocks. The overall workload of each block will increase to provide progressive overload throughout (Figure 2). For each of these periods, the various training factors undertaken by the BJJ athlete will be prioritized (Table 2). The physiological qualities enhanced in each block will potentiate the development of the targeted attributes in the following block (12,25,33,45). This will ultimately ensure optimal development of the abilities underpinning BJJ performance in time for competition.

Elite competitors. In the case of an elite BJJ athlete, an 18-week mesocycle is recommended. In this, 6 weeks will be allocated to each block. An incremental loading pattern will be used, with the first 4 weeks increasing in workload. In the final 2 weeks, the workload is lowered to provide restitution and allow adaptations to be realized before the next block (35,41).

Subelite competitors. For the subelite BJJ athlete, a series of 9-week mesocycles will allow multiple peaks for the frequent competitions held throughout the year. Here, 3 weeks should be allocated to each of the 3 blocks of training. An incremental loading pattern will again be used whereby the overall workload is increased over the first 2 weeks, whereas the final week contains a lower workload to allow regeneration before the increased stress of the following block (8).

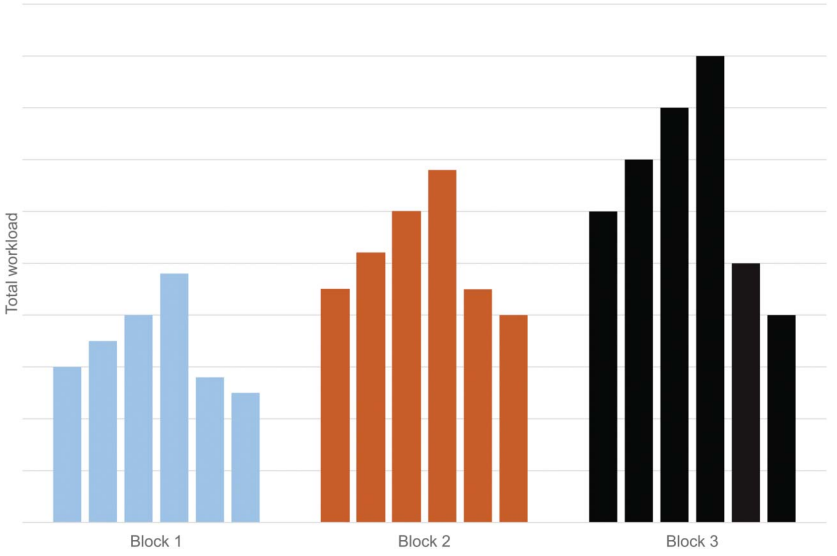

Figure 2. An incremental loading strategy to manage the overall training stress over a mesocycle. Adapted from Plisk and Stone (41) with permission of Lippincott, Williams, and Wilkins.

BLOCK 1

Resistance training. In accordance with the theory of sequential periodization, the resistance training emphasis of the initial stage of this mesocycle is increased muscular hypertrophy. This improved cross-sectional area contributes to the development of strength in the following block (33). Additionally, improvements in this quality are important to the BJJ athlete as it has been reported that elite competitors in this sport possess low body fat and high fat-free mass (3). Thus, the hypertrophic stimulus and metabolic demand experienced from this training is an important component in developing the BJJ athlete. Although the focus of this resistance training block is hypertrophy, maintenance loads of strength and power are included to minimize any detraining of these qualities. Throughout all blocks, structural exercises and other weightlifting variants are emphasized due to their superior ability to activate maximum muscle mass and promote strength and power adaptations (30). Table 3 presents the resistance training prescription for this period.

Metabolic conditioning. Less physiologically specific training tasks are characteristic of this stage of a training plan (41). As such, metabolic conditioning drills will be designed according to 1:1 Hi:Lo ratio for each period of work (Table 4). This emphasizes the development of oxidative metabolism (8), which is a key contributor to energy supply during a BJJ bout while still considering the intermittent intensity of the sport. Such improvements are brought upon through increases in hemoglobin affinity, pulmonary diffusion, stroke volume, cardiac output, and blood volume (19). These central adaptations pose less interference with the more peripheral adaptations that result from the concurrent hypertrophy training (21).

Technical and tactical training. Consistent with the principles of periodization, both the relative and proportional distribution of technical and tactical training is low during this early period of the mesocycle because of the considerable increases experienced later in

Table 2
Prioritization of training tasks within blocks and over a mesocycle

Priority	Block 1	Block 2	Block 3
1	Hypertrophy	Technical	Tactical
2	General conditioning	Strength	Technical
3	Technical	Metabolically specific conditioning	Metabolically specific conditioning
4	Tactical	Tactical	Power
5	Strength	Power	Strength
6	Power	Hypertrophy	Hypertrophy

the training plan (41). This promotes continual adaptations over the mesocycle and allows for the increased volume load (VL) characteristic of hypertrophy training activities undertaken during this block. Within sports-specific sessions, the volume of high-intensity "rolling" (live sparring) will likely be lower during this period, with the focus instead on improving technical proficiency.

BLOCK 2

Resistance training. The proportional workload of resistance training in this block decreases with a concomitant increase in sports-specific training. This decrease from the high VL experienced in the previous block allows the resistance training emphasis to now focus on the development of strength (Table 5). Adaptations are primarily from the central nervous system and include increases in maximal muscle activation (10) and rate of force development (24,43). Maintenance loads of hypertrophy and power are included to prevent the loss of fat-free mass and rapid force generating capacity, respectively.

Metabolic conditioning. In this block, metabolic conditioning becomes more physiologically specific to BJJ competition. Thus, these activities will consider the phases of higher- and lower-intensity effort within each period of work, in addition to the work to rest ratio itself. Conditioning is based on the understanding that 2 periods of work lasting 117 seconds (2) to 170 seconds (14) are typically executed and separated by approximately 20 seconds (2) of rest. Additionally, these periods of work contain a Hi:Lo ratio of approximately 1:8 to 1:5 represented by periods of high-intensity expressions lasting approximately 3–5 seconds followed by 25 seconds of low-intensity activity (2). Strategies based on these specific demands are presented in Table 6. These tasks elicit greater peripheral adaptations than conditioning methods in the previous block, such as increases in muscle glycogen stores, oxidative enzymes, and capillary and mitochondrial density (19). These peripheral adaptations are less likely to interfere with the predominately neural adaptations to the strength training prescribed in this period (21).

Technical and tactical training. As the mesocycle progresses, both the technical and tactical training increase in priority. This occurs through an increase

Table 3
Resistance training prescription for block 1

Monday/Saturday (heavy)			Wednesday (medium)
Power clean[a]			Deadlift[a]
Push press			Standing shoulder press
Back squat			Barbell row
Flat bench press			Single arm dumbbell chest press
Single-arm dumbbell row			Single leg squat
Loading schedule			
Week of block 2	**Sets**	**Reps**	**%1RM**
1	3, 3[b]	10	M/S: 70%; W: 60%
2	3, 4[b]	10	M/S: 75%; W: 65%
3	4, 2[b]	10	M/S: 70%; W: 60%
4	4	10	M/S: 75%; W: 65%
5	2	8	M/S: 75%; W: 65%
6	2	7	M/S: 75%; W: 65%

M = Monday; S = Saturday; W = Wednesday; 1RM = 1 repetition maximum.

[a]Strength and power maintenance, 5 reps at 85% 1RM.

[b]Subelite fighters using 3-week blocks.

Table 4
Block 1 general metabolic conditioning for all ranks

Work period	Sets of work periods	Rest between sets	Duration of the drill	Repetitions of the drill	Frequency
45 s at 100% MAS, 45 s at 70% MAS	4	0	6 min	3-week block	3
				Week 1 = 3	
				Week 2 = 4	
				Week 3 = 3	
				6-week block	
				Weeks 1, 2 = 3	
				Weeks 3, 4 = 4	
				Weeks 5, 6 = 3	
				1-min recovery between drills	

MAS = Maximum aerobic speed.

in workload and intensity. Developing the athlete's repertoire of escapes, submissions, positioning strategies, and other maneuvers becomes the focus. Rolling sessions increase in volume and intensity, giving the fighter extended opportunities to apply newly learned techniques. This also prepares the athlete for more tactical and strategic orientated training in the following block. Effective communication between the strength and conditioning and sports-specific coaches is necessary to ensure the aforementioned incremental loading and unloading strategies are applied.

Table 5
Resistance training prescription for block 2

Tuesday (heavy)		Friday (medium)	
Clean		Hang power clean and press	
Push jerk		Back squat[a]	
Deadlift		Incline dumbbell press	
Bench press[a]		Weighted chins	
Barbell row[a]		Split squat	
Loading schedule			
Week of block 2	**Sets**	**Reps**	**%1RM**
1	3, 3[b]	5	T: 80%; F: 70%
2	3, 4[b]	5	T: 85%; F: 70%
3	4, 2[b]	5	T: 85%; F: 70%
4	4	5	T: 90%; F: 75%
5	2	4	T: 90%; F: 70%
6	2	4	T: 90%; F: 70%

F = Friday; T = Tuesday; 1RM = 1 repetition maximum.

[a]An additional "down" set of 10 repetitions at 75% 1RM to be included for hypertrophy maintenance.

[b]Subelite fighters using 3-week blocks.

BLOCK 3

Resistance training. Training to attain maximal neuromuscular power becomes the resistance training focus of this block. As such, both force and velocity components are targeted by combination of loads, modalities, and movement patterns (Table 7). The highly neural adaptations resulting from this training complement the predominantly peripheral adaptations to high-intensity metabolic conditioning concurrently undertaken in this block (21). Relatively minimal VL is used during this period as technical and tactical training, in addition to metabolic conditioning, all increase in priority as the tournament draws closer. Although low in priority, maintenance loads of hypertrophy and strength are included to minimize detraining of these qualities.

Metabolic conditioning. Physiologically specific conditioning drills are continued in this block. It has been reported that low cardiovascular stress

Table 6
Block 2 and 3 physiologically specific conditioning tasks

Belt	Work period	Sets of work periods	Rest between sets, s	Total duration of the drill, min	Work:rest ratio	Repetitions of the drill
White, blue	Set 1: (resistance complex 1) × 5	2	30	5:30	10:1	B2: 2 times B3: 4 times Recovery equal to drill duration
	Set 2: (cyclical activity) × 5					
Purple, brown	Set 1: (resistance complex 1) × 5	3	30	8:30	7.5:1	
	Set 2: (cyclical activity) × 5					
	Set 3: (resistance complex 2) × 5					
Black	Set 1: (resistance complex 1) × 6	3	30	10	9:1	
	Set 2: (cyclical activity) × 6					
	Set 3: (resistance complex 2) × 6					

Contents of work periods representing a high:low ratio of 1:5.

Resistance complex 1: (25-second back squat, 5-second hang power clean) at 40% 1RM power clean.

Cyclical activity: (25 seconds at 80% MAS, 5-second maximal effort).

Resistance complex 2: (25-second reverse lunge, 5-second push jerk) at 40% 1RM power clean.

MAS = Maximum aerobic speed.

represented by heart rates of 165 beats per minute (bpm) (47) and 166 bpm (17) is experienced by BJJ athletes in response to a simulated bout, with a perceived exertion rating of low to somewhat hard (47). However, considerably higher heart rate (182 bpm) values have been recorded in response to actual competition (14). Thus, high-intensity conditioning drills are critical as they provide a physiological stimulus that more closely replicates the demands of a BJJ bout than sports-specific training itself. During this block, the frequency of these sessions decreases (Table 8) while the duration increases (Table 6) to more closely resemble a BJJ tournament structure where multiple bouts must be contested during the event.

Technical and tactical training. The priority of this block is tactical training. This will often be dictated by the technical proficiency of the athlete and the rules of the tournament. Higher levels of cortisol have been reported in BJJ competitors both before and after the official competition compared with simulated bouts (34). This suggests that BJJ athletes experience greater amounts of both psychological and physical stress during the competition than practice. Typically, the open rolling portion of BJJ sessions last extended periods (30+ minutes) and consist of minimal breaks, with all fighters sparring throughout. As such, the intensity is inherently lower than that of a tournament. Higher-intensity periods of live rolling with a greater duration of recovery would better match the physiological demands of a tournament and thus should be considered by coaches. A tournament structure could be mimicked, where only a single pair of athletes would roll under tournament rules while others observed. Such a structure would also add to the psychological stress imposed on the fighter (34).

RECOVERY STRATEGIES

As BJJ athletes have high workloads and often participate in multiple daily sessions, recovery strategies are required to minimize the impact of fatigue on training and competition performance. One of the most critical aspects of

Table 7
Resistance training prescription for block 3

Tuesday	Load% 1RM	Friday	Load% 1RM
Depth jump	0%	Hang power snatch	70–85% (50% for weeks 5, 6)
Power clean	85% (40% for week 6)	Clean pull (mid-thigh pull for weeks 5, 6)	80%
Push jerk	80% (40% for week 6)	Flat bench press[a]	85%
Jump squat	30%	Weighted chins[a]	
Standing med-ball toss	5 kg	Back squat (1/4 squat weeks 5, 6)[a]	85%

Loading schedule

Week of Block 3	Sets	Reps
1	3, 3[b]	5
2	3, 4[b]	5
3	4, 2[b]	5, 3[b]
4	4	5
5	2	3
6	2	3

1RM = 1 repetition maximum.

[a]Additional "down set" of 10 repetitions at 75% weeks 1–4 for elite fighters only.

[b]Subelite fighters utilizing 3-week blocks.

recovery is a correctly designed taper to allow the athlete to peak for their selected tournament. It has been suggested that BJJ athletes should taper by eliminating resistance training alone in the week before competition, while sports-specific and endurance training remains unchanged (29). This is in contrast to meta-analysis data (9), which indicates that an overall reduction in training volume of 40–60% should be prescribed to athletes over the 8–14 days leading up to competition. Thus, the removal of low-volume resistance training alone would result in only a minimal reduction to overall training load and would likely result in high levels of residual fatigue interfering with performance. The loading strategies proposed, whereby periods of restitution are included, inherently adhere to these tapering recommendations, and therefore allows for the dissipation of fatigue and maximization of performance gains. These loading strategies also provide periods of restitution throughout the training plan to promote recovery and adaptation (8), while the effective pairing (19) and sequencing (16,40,45) of training modalities minimizes the potential for overtraining (Table 2).

In addition to the management of training load, the use of cold water immersion is also an appealing option for fighters. Such a treatment has reported to decrease serum creatine phosphokinase, lactate dehydrogenase and maintain isometric strength to a greater extent than control conditions in BJJ athletes (44). Finally, optimal nutrition practices play a central role in recovery. However, it is beyond the scope of this article to explore this topic. As such, nutrition is recommended as an area of investigation in future discussions on BJJ performance.

Table 8
Metabolic conditioning session frequency for blocks 2 and 3

	Subelite frequency (3-week block)	Elite frequency (6-week block)
Block 2	Week 1: 2	Weeks 1–2: 2
	Week 2: 3	Weeks 3–4: 3
	Week 3: 2	Weeks 5–6: 2
Block 3	Week 1: 1	Weeks 1–2: 1
	Week 2: 2	Weeks 3–4: 2
	Week 3: 1	Week 5–6: 1

WARM-UP AND FLEXIBILITY

The inclusion of a well-designed warm-up is a crucial component of all training sessions and competitive events. This portion of a session should be centered on dynamic activities that aim to enhance motor control and improve mobility. Such tasks involve actively taking joints through increasing ranges of motion, under motor control, through a variety of movement patterns, including those that are similar to what will be encountered in the training session or event (7,15). These methods are documented to enhance performance and minimize injury risk (7), Additionally, cool down methods such as moderate intensity aerobic activity may assist in recovery (38) and therefore can be considered for inclusion in a training session or following competition.

CONCLUSIONS

BJJ requires valuable contributions from all major energy systems, in addition to the application of strength and power qualities. A well-designed training plan is needed to manage the development of each of these capacities to ensure peak performance during competition. A sequenced periodization strategy that combines physiologically compatible tasks within training blocks is presented as the ideal method for such a training plan. This strategy also discusses the manipulation of resistance training variables and the design of energetically specific metabolic conditioning drills, along with sports-specific training that accurately reflect the demands of competition. Taken together this training plan provides a thorough evidenced-based strategy for the development of the BJJ athlete.

Conflicts of Interest and Source of Funding: The author reports no conflicts of interest and no source of funding.

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