Periodization for Mixed Martial Arts

Lachlan P. James, MExercSc, MSportCoach,1,2 Vincent G. Kelly, BSc (Hons),1,3 and Emma M. Beckman, PhD1
1School of Human Movement Studies, University of Queensland, Brisbane, St. Lucia, Queensland, Australia; 2School of Exercise and Biomedical Sciences, Edith Cowan University, Joondalup, Western Australia, Australia; and 3UQ Sport Academy, University of Queensland, Brisbane, St. Lucia, Queensland, Australia

ABSTRACT

The mixed martial artist requires the development of a broad scope of divergent physiological abilities to compete successfully. To minimize any potential interference effects and optimize training adaptations, a periodized training plan is needed to manage the integration of this sport’s many training stressors. This article provides guidelines and practical examples for the strength and conditioning coach.

Mixed martial arts (MMA) is a unique and complex combat sport which uses a wide range of kicking, punching, and grappling techniques found in more traditional martial arts such as kickboxing, wrestling, Brazilian jiu-jitsu and karate. Because of the diversity in these attacking methods, a highly developed broad scope of physical abilities is needed to successfully compete. A well-prepared mixed martial artist will need to possess high levels of maximal strength and strength endurance in addition to the ability to express power repeatedly under loaded and unloaded conditions. Furthermore, the MMA athlete must have the physical resilience to absorb frequent high-intensity collisions. Finally, the sport has high-intensity intermittent endurance characteristics, thus it necessitates well-developed aerobic and anaerobic capacities (36,60).

This combination of qualities makes MMA unique from many other sports. An effective training plan should aim to develop optimally all these physical properties to ensure optimal preparation for competition. However, distinct mechanisms underpin adaptations to the varied training stimuli used to develop these abilities (38,46,68,88). Specifically, the divergent adaptations stemming from endurance and resistance training have been reported to cause conflict with strength and power development, limiting the extent of adaptation (39,56), in addition to increasing the risk of overtraining (20,31). This makes the development of an effective training plan for MMA a complex undertaking. To address this, a periodization framework is needed to manage these training stressors in a way that facilitates the effective development of each characteristic, manages the fatigue generated from the training stress, and allows the fighter to peak at predetermined points throughout the training plan.

Despite an increasing number of investigations into strength and conditioning methods for MMA, none have presented a detailed periodization framework which addresses the critical issue of interference effects from concurrent endurance and resistance training (5,6,17,55,78). The purpose of this article is to provide the strength and conditioning coach with a framework by which the major training tasks can be integrated. A detailed periodized training plan for MMA will be provided as a practical example to guide both the strength and conditioning practitioner and sports-specific coach.

KEY WORDS: mixed martial arts; combat sport; periodization; concurrent training

AEROBIC AND ANAEROBIC CAPACITY

The predominant contributor to energy supply after 3 minutes of activity is the aerobic system. Thus, the length of an MMA round and minimal recovery between rounds necessitates the athlete to draw heavily on aerobic metabolism (36). However, each round consists of intermittent activity expressed as a high intensity to lower intensity (Hi:Lo) ratio of 1:2 to 1:4 (28) (Figure 1). Such a work-to-recovery interval necessitates engagements from both fast and slow glycolysis in addition to oxidative metabolism (15). Therefore, physiologically, MMA is intermittent in nature requiring multiple high-intensity efforts, which underpin its high-intensity
intermittent endurance foundation (84). Amtmann et al. (7) measured postbout lactate levels reaching 18.7 and 20.7 mmol/L for bouts lasting regulation time. These levels are similar to those found in the grappling sports of wrestling (70) and judo (27). Because the end product of the fast glycolytic pathway is lactate, it can be concluded that mixed martial artists rely heavily on this system over the duration of a bout, particularly during brief grappling battles lasting approximately 30–90 seconds (15).

An investigation of the work-to-rest ratio of the component sports of MMA suggests that grappling arts have higher work-to-rest ratios than striking sports. A ratio of 3:1 has been determined for both judo (64) and wrestling (70), whereas striking arts such as muay Thai and taekwondo experience work-to-rest ratios of 2:3 (79) and 1:6 (59), respectively. Thus, it seems as though MMA possesses an intensity that falls between grappling and striking sports. However, the decisive nature of MMA grappling encounters (28) and the high blood lactate levels suggest that grappling, rather than striking, represents the greater proportion of engagements in MMA. In addition to these findings, it has been reported that approximately 77% of fights were decided during high-intensity striking or grappling sequences either standing or on the ground, lasting 8–14 seconds (28).

Because the ATP-PC and fast glycolysis are the primary systems used for high-intensity expressions lasting 6 to 30 seconds (15), it can be concluded that the repeated engagement of these systems fuel decisive encounters in MMA.

**STRENGTH**

The grappling battles experienced by MMA athletes resemble that of wrestling and thus require expressions of both dynamic and isometric strength (53). Del Vecchio et al. (28) determined that approximately 50% of fights ended during ground fighting action. Thus, the development of this characteristic can contribute to the performance enhancement of a decisive MMA skill. Moreover, strength forms the foundation for the development of power (23, 24), and significant improvements in athletic performance have been well documented as a result of training induced increases in strength (22, 50, 85, 90, 91).

**POWER**

The delivery of strikes including punches and kicks require rapid application of force under unloaded conditions. Aagaard et al. (3) noted that a punch is delivered in 50–250 milliseconds, thus, exceptional rate of force development (RFD) capabilities are required. In the only investigation using elite MMA athletes, McGill et al. (62) determined that a rapid contraction-relaxation strategy of trunk musculature is used when performing powerful punching and kicking actions. Additionally, when executing takedowns, forces applied at high rates against the mass of an opponent are required. Thus, the expression of power under loaded conditions is also a key element of MMA. In the sport of rugby league that has physiological characteristics similar to MMA including frequent tackling collisions with high-intensity intermittent endurance demands, it was determined that the ability to express power under loaded conditions differentiated elite from subelite players (8, 10, 12). It is possible, then, that power may also be the defining physiological ability of high-level MMA athletes. However, further investigations are needed to determine the characteristics of elite mixed martial artists.

**PHYSIOLOGICAL ADAPTATIONS TO CONCURRENT TRAINING**

A successful MMA athlete will need to employ a number of training tasks over the course of a training plan to develop these capacities. Energy system conditioning and resistance training in addition to technical and tactical sessions of varying intensities will be the key factors manipulated to achieve performance gains. Underlying the effective integration of these tasks are their chronic and acute physiological responses. Because endurance-training stimuli can illicit differing and conflicting adaptations to resistance training tasks, close attention must be paid to the management of these distinct modalities to minimize interference effects. Although there have been no investigations into the periodization of an MMA training plan, there is a depth of research that has examined the effects of concurrent endurance and resistance training programs. Understanding this research will assist in the design of an effective periodized training plan.
training plan to manage the training stressors of MMA.

Reports of interference effects stemming from the concurrent training of aerobic and resistance training modalities are well documented in the scientific literature (25,36,39,41,45,48,52,56). A seminal study by Hickson (45) investigated the effects of concurrent strength and endurance training in untrained individuals. By the end of the 10-week training program, strength levels were significantly lower in the combined strength and endurance group compared with the strength only group. Consistent with these findings, Romnøst et al. (76) found significantly greater increases in strength, thigh cross-sectional area, jump squat performance, and RFD in subjects performing strength training only when compared with elite endurance athletes performing concurrent strength and endurance training. For the MMA athlete, this suggests that high volumes of low-intensity aerobic-based training will certainly limit the ability to enhance strength and power levels. This effect would be particularly apparent if the MMA athlete was undertaking a large workload of physiologically non-specific continuous conditioning at a low intensity for an extended duration, otherwise known as long slow distance (LSD) (15) in conjunction with strength-power training. However, because aerobic and anaerobic capacity are important qualities for the mixed martial artist, alternate training methods should be applied that promote these adaptations while forming a more fitting complement to the development of key strength and power abilities. Conversely, the inclusion of resistance training has been reported to improve performance in endurance athletes (13,44,49,65,66,71,75,77,80) in addition to improvements in maximal strength (1,2,14,44) and RFD (1,2). Thus, further to the well-understood improvements in strength and power, the inclusion of resistance training to an MMA training plan has the potential to enhance endurance performance. However, caution must be applied by managing the overall training workload to allow for the incorporation of this additional training factor. Taken together, this suggests that technical, tactical, energy system, and resistance training should be prioritized in a way that considers these effects. The prioritization will be dependent on the stage of the training plan and the individual abilities of the athlete. Additionally, strategies that promote aerobic, anaerobic, strength, and power adaptations with minimal interference should be used.

**CONCURRENT ENDURANCE AND RESISTANCE TRAINING**

These findings highlight the complexity faced when developing the MMA athlete. A framework is needed to minimize these interference effects and facilitating the concurrent development of opposing physiological abilities. García-Pallarés et al. (35) proposed a block periodization strategy for the concurrent development of strength, power, and endurance that considers the effects of training modalities at the central and peripheral level. To account for this, hypertrophic resistance training was paired with lower-intensity interval training (LIIT) occurring at 75–85% $\text{VO}_{2}\text{max}$ in a training block, whereas strength and power development were paired with high-intensity interval training (HIIT). Underpinning this framework is the suggestion that opposing physiological adaptations occur at the peripheral level between hypertrophy training and HIIT (56). Here, the high metabolic stress induced by HIIT would interfere with peripheral anatomical adaptations, whereas LIIT elicits primarily central adaptations, and therefore poses less interference. In accordance with this model, the predominantly neural adaptations to strength and power training are a more fitting complement to the peripheral adaptations of HIIT. This strategy significantly improved endurance, strength, and power performance markers in high-level athletes (35).

Providing further support to the effectiveness of periodization in developing conflicting abilities are investigations by Baker (9) and Baker and Newton (11). These studies demonstrated that elite rugby league players could develop strength and power over a 4-year period (11) and maintain these abilities over a 29-week competitive season with high volumes of aerobic and anaerobic activities. Moreover, subelite players were able to increase strength with equally high levels of concurrent endurance training over a season (9) and further develop both strength and power over a 4-year period (11). Although the framework was not described, it was suggested that the periodization of this training including the sequencing of modalities and prioritization of training goals allowed for this effective concurrent development of endurance and strength qualities (9,11).

These findings suggest that despite conflicting mechanisms underpinning the adaptations to various MMA training modalities, it is feasible to develop strength, power, and endurance concurrently in athletes. However, poorly organizing these modalities will limit performance gains. Thus, to effectively arrange these modalities and optimally prepare the MMA athlete for competition, a periodization framework should be used.

**PERIODIZATION OF AN MMA PROGRAM**

The primary training factors of MMA can be broadly classified as technical, tactical, conditioning, and resistance training. Table 1 shows an example of how these factors can be prioritized across a macrocycle. The classic model of periodization suggests that nonspecific training like general conditioning be introduced initially, with more specific tactical and technical training occurring in greater volumes as the event approaches (73).

Caution is advised with the inclusion of continuous endurance training such as LSD because of a lack of specificity to the intermittent nature of MMA and more severe impact on strength and power development than interval training strategies (15). Thus, LIIT at a 1:1 work-to-rest ratio should be applied during the early stages of the training plan. The use of García-Pallarés et al’s (35) model in pairing...
resistance and endurance-training modalities in specific training blocks should be considered. Conditioning in the form of LIIT will be paired with higher-volume resistance training whereas strength and strength-power training is paired with HIIT. Here, the peripheral adaptations to hypertrophy resistance training should pose less interference with LIIT than HIIT. LIIT should progress to more specific HIIT after the early stages of the mesocycle. Peripheral adaptations stemming from HIIT forms a fitting complement to the predominantly neural adaptations of strength and strength-power training for the remainder of the cycle. The decreased volume load (VL) from strength and strength-power training, compared with hypertrophy training, makes way for additional volumes from HIIT and technical and tactical activities. Another important factor is the tendency for HIIT to increase type II fiber concentration (26). This adaptation increases RFD (51,54), maximal force production capabilities (51), and maximal power output (86), which match the mechanisms underpinning adaptations to strength-power training (21).

The following section provides an example of the specific preparation period within a training plan. Detailed guidelines will be presented for weeks 5, 6, 7, and 8 of a 13-week macrocycle, culminating in a high-level amateur bout. The integration of training factors, the management and distribution of training load, and the design of physiologically specific energy system training are presented. In summary, this 4-week mesocycle will combine strength development with HIIT, in addition to technical and tactical training.

**Table 1**
The configuration of training tasks within a mesocycle and over a macrocycle

<table>
<thead>
<tr>
<th>Order of priority</th>
<th>Mesocycle 1: general preparation</th>
<th>Mesocycle 2: specific preparation</th>
<th>Mesocycle 3: Precompetition</th>
<th>Taper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Interval training using 1:1 HiLo ratio</td>
<td>Technical</td>
<td>Tactical</td>
<td>8–14 d in duration. Reduce overall training stress by 40–60%</td>
</tr>
<tr>
<td>2</td>
<td>Hypertrophy training</td>
<td>High-intensity energy system conditioning using 1:2 HiLo ratio</td>
<td>Technical</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Technical</td>
<td>Strength training</td>
<td>High-intensity energy system conditioning using 1:2 HiLo ratio</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Tactical</td>
<td>Tactical</td>
<td>Strength-power training</td>
<td></td>
</tr>
</tbody>
</table>

The distribution of training load

This proposed block periodization model prioritizes, vertically integrates, and horizontally sequences the training factors of MMA. Such a strategy has proven to be the superior design for athletes participating in concurrent training (33,72). Each successive mesocycle will have a greater overall training stress to continue to promote training adaptations (73) (Figure 2). A 3:1-loading paradigm will be used for each mesocycle (73). Here, the training stress will increase over the first 3 weeks, whereas the final week provides a period of restitution before the increased training load of the next mesocycle. This strategy allows super-compensation and the performance gains from the mesocycle to be realized (82).

In accordance with the principles of periodization, technical sessions increase in priority (73). This training is athlete specific, targeting technical flaws and fine-tuning other techniques. This is in contrast to tactical sessions, which involve strategies specific to the upcoming opponent. As a more developed technical ability and increased conditioning dictates the strategic options for an MMA fighter, tactical sessions remain a lower priority until the final mesocycle. The VL of resistance training decreases as the athlete moves from the development of hypertrophy to strength. This makes way for the increased
volume of technical and energy system training. Relative distribution of the training workloads for this period is presented in Figure 3 and Table 1. Table 2 depicts the weekly schedule for these training tasks.

**MONITORING**

A large volume of concurrent training, as is common in an MMA training plan, increases the risk of overtraining (20,31) necessitating careful athlete monitoring of fatigue state. To monitor training load and its impact on fatigue effectively, a number of strategies are recommended. The loads should be preplanned and based on the capacity of the individual. Self-reporting should assist in athlete monitoring by recording fatigue level, sleep quality, resting morning heart rate, and rate of perceived exertion using questionnaires such as RESTQ-Sport, profile of mood states, and total quality recovery. Training loads should be modified if this monitoring data provide evidence of increased fatigue.

Field tests should be conducted during the first week of each mesocycle to

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**Figure 2.** A 3:1-loading paradigm used to manage the overall training stress over a macrocycle. The last week of the pre-competition mesocycle forms the first week of the 2-week taper (73).

**Figure 3.** Distribution of training workloads over the specific preparation mesocycle.
<table>
<thead>
<tr>
<th>Week 5</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
<td>Energy system conditioning</td>
<td>Technical</td>
<td>Technical</td>
<td>Recovery day</td>
</tr>
<tr>
<td>Lunch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evening</td>
<td>Energy system conditioning</td>
<td>Strength training</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 6</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
</tr>
<tr>
<td>Lunch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Energy system conditioning</td>
</tr>
<tr>
<td>Evening</td>
<td>Energy system conditioning</td>
<td>Strength training</td>
<td>Energy system conditioning</td>
<td></td>
<td>Strength training</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 7</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
</tr>
<tr>
<td>Lunch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Energy system conditioning</td>
</tr>
<tr>
<td>Evening</td>
<td>Energy system conditioning</td>
<td>Strength training</td>
<td>Energy system conditioning</td>
<td>Energy system conditioning</td>
<td>Strength training</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 8</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
<td>Energy system conditioning</td>
<td>Technical</td>
<td>Technical</td>
<td>Technical</td>
</tr>
<tr>
<td>Lunch</td>
<td></td>
<td></td>
<td></td>
<td>Energy system conditioning</td>
<td></td>
<td></td>
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<tr>
<td>Evening</td>
<td>Energy system conditioning</td>
<td>Strength training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Strength training</td>
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</tbody>
</table>
determine the athlete’s preparedness and to monitor the impact of the previous training cycle (Table 3). These performance tests will assist in identifying any deficiencies in the athlete’s physiological abilities. This information should also be presented to sports-specific coaches to help determine the prioritization of training tasks (thus allocation of workloads) over the mesocycle and within each block. For example, a highly technical fighter may be found to lack HIIT capacity, thus, energy system conditioning may be prioritized over technical work in a training block. Alternatively, an athlete may have low strength, and the development of this capacity may increase in priority. Special attention must be paid to the potential interference effects that can impact adaptations. Thus, if an increase in strength or power is desired, it would be beneficial to lower endurance-training workload.

**RESISTANCE TRAINING**

The development of strength in this mesocycle is in accordance with the theory of sequenced training. This method suggests that the development of one ability potentiates the development of the next (47,83). Thus, each training period should facilitate the improvement of the following period. This is suggested to be the superior approach when developing a training plan (23,40,63,72,83,91). Targeting muscular hypertrophy in the previous mesocycle stimulates increases in cross-sectional area, anaerobic capacity, and fat-free mass, which provides the foundation for the development of strength in the following block (82). However, caution should be applied to prevent additional hypertrophy from interfering with the athlete’s ability to reach the required weight for their class. The improved strength aids in the development of power in the following mesocycle (23). The resistance training frequency, volume, and loading should fall within the optimal bandwidth for high-level concurrently training athletes (34). Additionally, to provide necessary unloading, the presented program incorporates only 2 sets in the final week of this mesocycle. Heavy and light days are included to provide reasonable variation in intensity, which optimizes recovery and adaptation (32,81).

The principle of dynamic correspondence (19) would suggest that multijoint exercises including weightlifting activities are ideal. In accordance with the findings of Izquierdo-Gabarren et al. (48), special coaches to help determine the optimal bandwidth for high-level concurrently training athletes (34). Additionally, to provide necessary unloading, the presented program incorporates only 2 sets in the final week of this mesocycle. Heavy and light days are included to provide reasonable variation in intensity, which optimizes recovery and adaptation (32,81).

The sequenced approach to this training plan aims for maximal power generating capacity to peak on completion of the final mesocycle, thus, the resistance training emphasis of this period is directed toward the force portion of the force-velocity relationship. However, the weightlifting activities and their variations that are included allow for the development of both force and velocity components (19). Velocity-specific improvements are trained in this period through the inclusion of plyometric-type, and low-load ballistic and weightlifting tasks during energy system training and technical sessions. Such modalities are understood to impact the velocity portion of the force-velocity relationship (24). This mixed-methods approach is recognized as the superior method for developing power (69).

**ENERGY SYSTEM TRAINING**

As LIIT delivers improvements predominately in aerobic capacity, it may be suitable for inclusion in the early stages of a training plan. However, this should shift to HIIT strategies, which are bioenergetically specific to an MMA bout. MMA’s reported high intensity to low intensity (Hi:Lo) ratio of 1:2 to 1:4 (28) should be used to guide the design of energy system training. In the example presented (Table 5), a 1:2 Hi:Lo ratio is used and would allow a fighter to effectively prepare for an anticipated grappling-dominant fight. This is in accordance with the indication that grappling sports have higher work-to-rest ratio than striking sports (18,59,64,70). A 1:4 Hi:Lo ratio could be used for bouts in which striking exchanges are expected to predominate. Additionally, the work intervals consider the finding that approximately 77% of fights were decided during high-intensity sequences lasting 8–15 seconds (28). Each set of work-to-

<table>
<thead>
<tr>
<th>Ability</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unloaded power output</td>
<td>Countermovement jump</td>
</tr>
<tr>
<td>Loaded upper-body power output⁸</td>
<td>Ballistic bench press throw at 55% of 1 repetition maximum (1RM)</td>
</tr>
<tr>
<td>Loaded lower-body power output⁹</td>
<td>Jump squat at a load representing the weight class of the athlete⁸</td>
</tr>
<tr>
<td>Upper-body dynamic strength</td>
<td>1RM bench press</td>
</tr>
<tr>
<td>Lower-body dynamic strength</td>
<td>1RM back squat</td>
</tr>
<tr>
<td>Intermittent aerobic and anaerobic capacity</td>
<td>Yo-Yo Intermittent recovery level 2 test</td>
</tr>
<tr>
<td>1RM = repetition maximum.</td>
<td></td>
</tr>
</tbody>
</table>

⁸These tests will be conducted if a linear position transducer is available.

⁹For example, a fighter competing in the 77-kg weight class will use 77 kg for this test. This reflects the expression of power against an opponent during many standing grappling exchanges.
recovery sequences lasts approximately 5 minutes, which replicates the duration of a round.

In addition to greater specificity, the progression to HIIT in this mesocycle minimizes the disruption to the development of strength (51), power (86), and RFD (51,54) while simultaneously improving both low-intensity exercise endurance and HIIT capacity (57,74,87). This form of interval training can shift the lactate threshold and onset of blood lactate to the right (29,42) eliciting improvements in lactate buffering capacity, which is critical considering the high lactate levels experienced by MMA athletes (7). Energy system conditioning strategies can use resistance training, cyclic activities, or more sports-specific modalities such as grappling and striking drills (Table 5). In accordance with the 3:1 loading pattern, training stress is increased over the first 3 weeks, whereas a considerable decrease is prescribed in the final week (Table 6). Furthermore, no conditioning using MMA-specific activities is prescribed in this final week to allow restitution from the intense collisions associated with this mode.

**TECHNICAL TRAINING**

Because of the large number of disciplines that compose MMA, technical sessions likely comprise a greater portion of a training plan than many other single-event sports. Such sessions usually include Brazilian jiu-jitsu, wrestling, boxing, muay Thai boxing, or a combination of these. Technical training may occur 6 days per week, and in many cases, more than once per day. These sessions often consist of learning or fine-tuning specific techniques, followed by a period of live sparring in positions where the technique can be applied. However, sparring sessions may also be delivered independently of other activities.

As technical sessions increase in priority, the sports-specific coach will be directed to increase the training workload for this mesocycle, distributing the training workload in accordance with the 3:1-loading paradigm used. Methods for achieving this can be by the inclusion or removal of sessions or adjusting the duration of the session. Furthermore, the intensity or duration of the live sparring component can be

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**Table 4**

**Strength training prescription**

<table>
<thead>
<tr>
<th>Tuesday (heavy)</th>
<th>Friday (medium)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean</td>
<td>Hang power clean and press</td>
</tr>
<tr>
<td>Push press</td>
<td>Back squat</td>
</tr>
<tr>
<td>Deadlift</td>
<td>DB Press</td>
</tr>
<tr>
<td>Bench press</td>
<td>Single-arm DB row</td>
</tr>
<tr>
<td>Barbell row</td>
<td>Stiff-leg deadlift</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Loading schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Week</strong></td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
</tbody>
</table>

DB, dumbbell; F, Friday; T, Tuesday.

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**Table 5**

**Energy system training strategies based on a HiLo ratio of 1:2**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Set length</th>
<th>Work intervals</th>
<th>Recovery</th>
<th>No. Repetitions</th>
<th>Sets Rest (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports-specific</td>
<td>5 min</td>
<td>A takedown against a resisting opponent, or 10-s striking combination</td>
<td>20-s low-intensity grappling or sparring</td>
<td>10</td>
<td>Week 5:5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Week 6:6</td>
</tr>
<tr>
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<td></td>
<td>Week 7:7</td>
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<td></td>
<td></td>
<td></td>
<td>Week 8:4</td>
</tr>
<tr>
<td>Resistance complex</td>
<td>5 min 15 s</td>
<td>15 s of either hang power clean/clean/high pull/push press. Change each work interval. At 40% 1RM hang power clean</td>
<td>30-s back squat. At 40% 1RM hang power clean</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Rowing, cycling, running, or combination</td>
<td>5 min 15 s</td>
<td>15 s at 110–120% maximal aerobic speed</td>
<td>30 s at 70% maximal aerobic speed</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
altered to meet the requirements of the period (Table 7). Because of the low prioritization of tactical sessions in this mesocycle, such tasks can be easily integrated into technical sessions without extending the training time excessively. Technical workouts should be scheduled early in the day to minimize the potential for fatigue to interfere with the skill acquisition required from these sessions. The 24 hour period between sessions, including sleep, will aid in the consolidation of these complex motor skills (89).

INJURY PREVENTION
Many MMA techniques require superior neuromuscular control of the athlete’s center of mass over their base of support, and of the lower limbs themselves. Deficiencies in these areas, which lead to valgus collapse about an excessively extended knee, are reported to increase the risk of noncontact anterior cruciate ligament injury (4,43). Improvements in neuromuscular control seem to reduce the risk of such injuries (37). Injury prevention strategies that focus on precise lower limb alignment during specific plyometric and ballistic tasks are recommended. Such exercises may include depth drop variations, progressing to single-leg-bound and stick actions. These may be included in the dynamic warm-up at a submaximal effort. Additionally, such activities, performed with greater degrees of effort, will form a fitting complement to strength-power resistance sessions in the following mesocycle. Close qualitative analysis of the ballistic and plyometric actions used in energy system conditioning should be undertaken to ensure that precision of movement is maintained when in a fatigued state. Implicit learning strategies are to be applied throughout to aid in the motor learning process (58).

Application of close qualitative analysis and feedback on movement quality in technical and tactical sessions will provide further opportunities to improve neuromuscular control.

TAPERING
Although this discussion focuses on the specific preparation period, it is important that strength and conditioning coaches have a general understanding of tapering. An effective taper reduces overall training stress, allowing fatigue to dissipate, thereby maximizing preparedness. It has been shown that a correctly designed and implemented taper can improve performance to varying degrees depending on the training type and characteristics of the athlete. A meta-analysis of tapering data on endurance performance shows that the most effective strategy is to implement an 8-day to 2-week taper that reduces training volume by 41–60% (16). Furthermore, it seems as though a reduction in training volume while intensity and frequency are maintained has the most positive effects on performance in highly trained athletes (67). In this example, the taper begins 2 weeks before the bout with a 40% reduction in training load followed by a further 20% reduction of pretaper training load in the final week before competition.

CONCLUSIONS
MMA is a complex sport requiring the concurrent development of a broad scope of abilities. The development of these attributes requires training interventions which illicit distinct and often conflicting adaptations. This increases the risk of mismanaged training workloads and poorly integrated training tasks, which will certainly limit performance gains and may lead to overtraining or injury. However, by understanding the potential conflicts stemming from divergent training stimuli, an effective periodization strategy can be developed. This will direct the management of fatigue and recovery while pairing complementary endurance and resistance training modalities and sequencing targeted abilities. By using these strategies, the strength and conditioning coach can effectively assist in the short-term and

<table>
<thead>
<tr>
<th>Week</th>
<th>No. sessions</th>
<th>Duration (min)</th>
<th>Sparring/live application component (min)</th>
<th>Intensity of sparring component</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>5</td>
<td>90</td>
<td>30</td>
<td>M</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>90</td>
<td>30</td>
<td>H</td>
</tr>
<tr>
<td>7</td>
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<td>45</td>
<td>H</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>60</td>
<td>20</td>
<td>L</td>
</tr>
</tbody>
</table>

L = low; M = medium; H = high.
long-term development of the MMA athlete.

Conflicts of Interest and Source of Funding: The authors report no conflicts of interest and no source of funding.

Lachlan P. James is the owner and strength and conditioning coach at Athletic Kinetics, Vancouver, Canada.

Vincent G. Kelly is a Conjoint Associate Lecturer in Sport and Science and Exercise Physiology at the School of Human Movement Studies, University of Queensland, Australia.

Emma M. Beckman is a lecturer in Clinical Exercise Physiology at the School of Human Movement Studies, University of Queensland, Australia.

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