A CROSS-SECTIONAL PERFORMANCE ANALYSIS AND PROJECTION OF THE UFC ATHLETE

UFC PERFORMANCE INSTITUTE

2018

VOLUME **ONE**

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ACKNOWLEDGMENTS

The creation of this journal, and further, the conceptualization and operation of the UFC Performance Institute, could not have been possible without the support of many key individuals along the way.

On behalf of the UFC Performance Institute team, I'd like to thank former UFC Chief Executive Officer Lorenzo Fertitta, Endeavor Chief Executive Officer Ari Emanuel, UFC President Dana White, UFC Chief Operating Officer Lawrence Epstein, UFC Chief Financial Officer Andrew Schleimer, former UFC Chief Global Brand Officer Garry Cook and Ardent Sports Managing Director Nick Smith.

To the athletes, coaches, support staff, fans and media that comprise the MMA community, thank you for affording us the opportunity and the platform to serve you and to play a role in the evolution of the greatest sport on earth.

JAMES KIMBALL
VICE PRESIDENT, OPERATIONS
UFC PERFORMANCE INSTITUTE

INTRODUCTION

FORREST GRIFFIN
VICE PRESIDENT OF ATHLETE DEVELOPMENT

Forrest Griffin serves as Vice President of Athlete Development for UFC. Griffin joined UFC's front office following a Hall of Fame career that included winning the inaugural season of the groundbreaking reality show The Ultimate Fighter® and capturing the light heavyweight championship. In his current role, Griffin is responsible for developing and executing key athlete-based initiatives, as well as supporting the conception, expansion, and implementation of the UFC Performance Institute.

Having come to mixed martial arts from other sports, I was surprised by the lack of an established, clear and concise method for how to physically prepare for MMA. Later in my career, when I could afford to, I attempted to develop a holistic training approach incorporating MMA skill training, strength and conditioning (led by a coach with more than an online certification), physical therapy and nutrition. This system, however, was not as effective as I had hoped. The reason was simple: lack of integration. There was no collaboration between coaches. Each coach would ask 100% of me for every training session, irrespective of what training I had just completed or what I was doing next. I knew I had all the right pieces, but I was unable to structure them in a cohesive manner that allowed me to perform at an optimal level on fight night, rather than one or two weeks before.

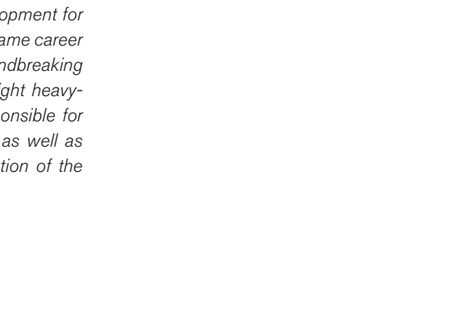
I was left, like most athletes and coaches at the time, with more questions than answers. How does strength training integrate with MMA skill training? How many times do you have to drill a skill before it is locked into your muscle memory? Is muscle memory a thing? How do fighters know what physical traits to work on out of camp based on their individual fighting style? How long should a camp be? Where do babies come from? You get the idea. Nobody could ever give me evidence-based answers that wholly satisfied these questions. And that is because the canon of training for modern MMA had not yet been defined. All of this to say I have an unhealthy obsession with finding the best, most effective way to train for MMA.

Our team at the UFC Performance Institute does not have all of the answers. Yet. But we do have the most comprehensive approach to asking the right questions and access to data to obtain the answers.

We've looked at historical fight trends to determine what it takes to win across every weight class in each gender. We've examined injuries that have occurred, when they occurred and ways to prevent them from happening again. We've worked to identify effective strategies for strength and conditioning programming and periodization, in addition to the key physical attributes of the UFC athlete. We've analyzed statistics around weight management, making weight and its effect on performance. And most important, we've built a performance paradigm reflecting all of this information, attempting to answer the very question that has eluded us all—simply put: *how to train for MMA*.

"Sharing best practices for performance optimization with athletes and coaches around the world."

That was our ambition for the UFC Performance Institute when it was conceptualized three years ago, and it remains our primary objective after our first year of operation. Working with hundreds of UFC athletes since we opened our doors has allowed us to collect and analyze over 30,000 various performance metrics and data points. This journal represents our findings and beliefs.



CHAPTER ONE

WINNING IN TODAY'S UFC

WITHOUT KNOWING YOUR DESTINATION, YOU HAVE NO DIRECTION

To win in any competition, having a clear understanding of the goal or target defines your probability of success. Only by identifying the level that must be achieved in order to prevail can an individual acknowledge the standards that must be transcended for victory. Nowhere else is this more apparent than during the chaos of the prize fight, where the margin between winning and losing is small. However, simply understanding a goal, target or destination is only part of any performance puzzle. Indeed, *"understanding the height of a mountain is one thing, but understanding the shape of the mountain is crucial when deciding the best way to get to the top!"*

Consideration of the respective components that underpin winning is critical if we are to accurately evaluate how challenging it will be to reach a required standard. So-called 'determinants of performance' are the variables that go into making a task, challenge or performance what it is; each variable has a direct influence on the level at which the target is set. These determinants of performance represent the individual building blocks of the performance itself, and collectively manipulate the level of the goal or performance standard.

Competition in the UFC has a complexity unlike any other sport. With technical, tactical, physical and psychological components all affecting a framework that has different fighting styles, weight classes, gender differences, and the lack of a clearly defined athlete profile, UFC is among the world's most complex sports. So how do we best understand the destination that is a UFC World Championship, and what is the best way to get there?

To begin to define 'What it Takes to Win' in the UFC, we must first seek to understand the characteristics of competition and the respective components that formulate the fight. Since 2002, over **3,900 individual UFC bouts** have taken place, and this is where we start our journey. We start at the 'destination,' and once we know where we are going, we can create the best pathway to get there. Only then are we able to begin to define 'What it Takes to Win' in today's UFC.

FIGHT DURATION

In 2002, the average duration of a UFC bout was 8:06. (see figure 1.1) Through 2008 there was little change, with fight duration only increasing by 3.9%. After 2008 fight times steadily increased, with fights in 2017 lasting on average 10:43. Throughout the 16-year period starting in 2002, UFC fights have gotten longer by 2:37, a 32.2% change. With no major changes in rules or regulations before 2017, we can speculate why fights may last longer (e.g. referees standing fighters up more, the growing influence of defensive techniques, athletes being better physically prepared, or greater parody in match making). Regardless, fighters and coaches must consider the implications that a longer fight may have on tactics, strategy and/or their approach to physical preparation.

Importantly, when considering the average fight time by weight class, trends become apparent. (see figure 1.2) A near-linear incremental relationship in fight duration exists from heavyweights through to the lightest 115lb women strawweights (n.b. there is insufficient data for women's 125lb and 145lb weight classes to be considered for analysis). The difference between heavyweight and strawweight bout duration is 4:33; almost equivalent to a full round of competition in UFC. Within the men's division, there is a 3:50 difference between heavyweight and flyweight bouts. With the exception of a slight anomaly for the 135lb men's bantamweight, the linear increment in average bout duration is 30.3 sec per weight class from heavyweight to strawweight.

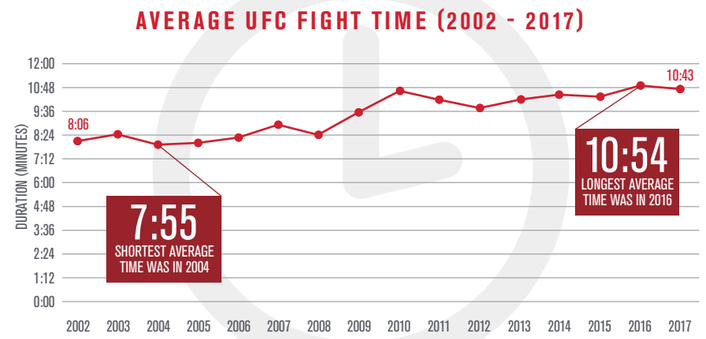


Figure 1.1

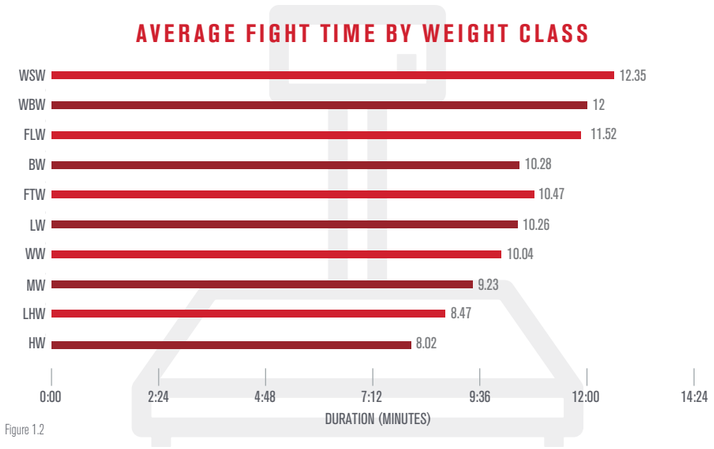
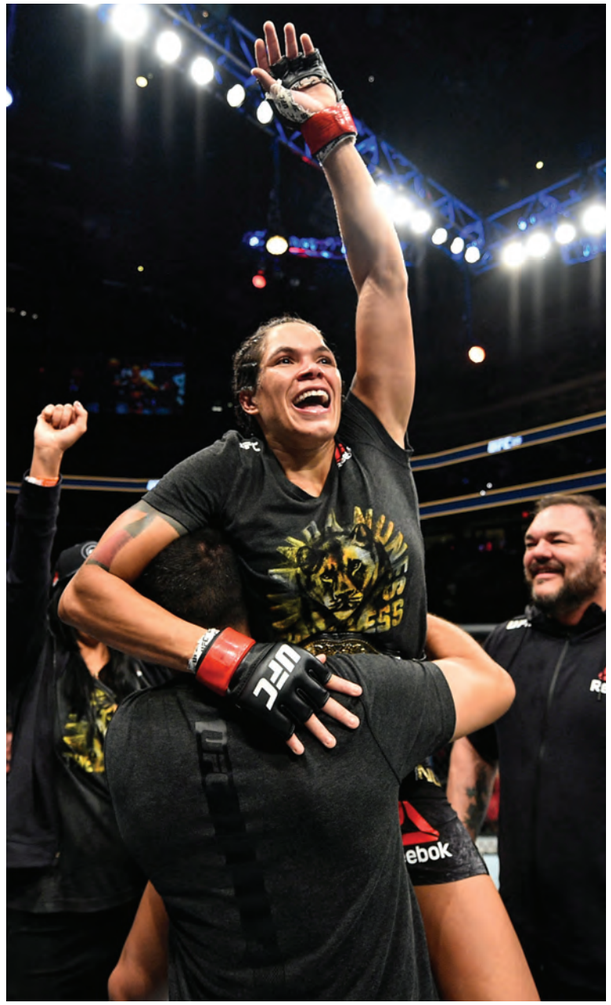


Figure 1.2

WIN METHODS

While insights on fight duration can potentially influence preparation in terms of strategy, psychology and physical conditioning, taken alone it provides limited value in terms of defining 'What it Takes to Win.' In a sport like MMA, where a variety of methods can be used to win the fight, it is important to understand the manner in which fights are won. In 2002, 54.7% of all fights were finished by KO/TKO (see figure 1.3). In 2017, that number was only 31.9%. This reduction in knockout finishes happened concurrently with an increase in fights going to decision (28.3% to 50.3%). Ranging between 15.1% and 31.6% since 2002, submissions in 2017 accounted for only 16.5% of wins. Interestingly, during the eight-year period from 2002-09, there was a 37.1% change (↓) in KO/TKOs, while in the subsequent eight years from 2009-2017, there was only a 7.2% (↓) change in fights won by KO/TKO. Similarly, the change in decisions was 51.2% from 2002-09 (↑), and only 17.2% (↑) from 2009-17. It is clear that over the past eight years the means by which fights are won or lost has stabilized.

Data indicate that weight class clearly influences fight characteristics (see figure 1.4). Across all weight classes, heavier bodies have a higher incidence of KO/TKO finishes, regardless of gender. An average of 60.1% of all heavyweight fights are finished by KO/TKO, with only 26.5% going to decision. Only 20.5% of male 125lb flyweight bouts are finished by KO/TKO, with the majority (60.3%) going to a decision. Similar trends are also apparent in female weight classes, with 29.4% of 135lb bantamweight bouts being finished by KO/TKO, and only 7.1% of 115lb strawweight fighters winning by KO/TKO. Perhaps most interesting, the women's strawweight division has the highest percentage of fights won by submission across all weight classes (27.1%). Using win-method-by-weight-class data, the value of examining specific determinants of success begins to become apparent. Indeed, by understanding how fights are won, it is possible to be more strategic in shaping performance and to direct training strategy accordingly.



WIN METHODS IN UFC (2002 - 2017)

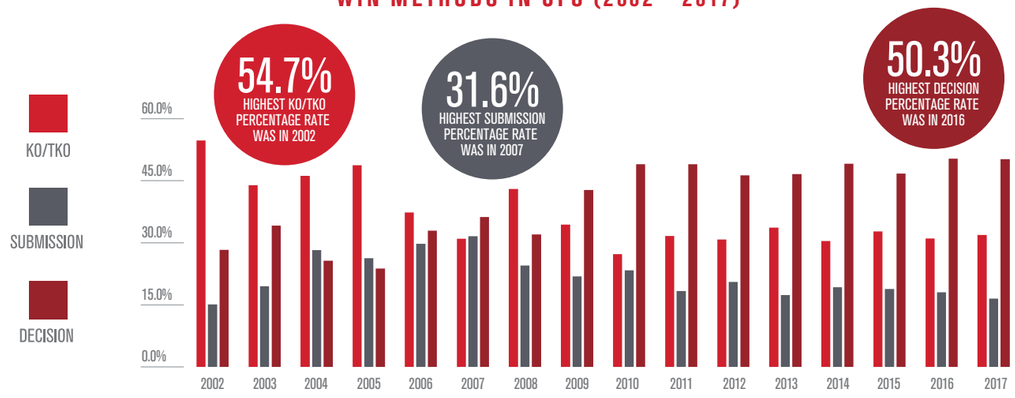


Figure 1.3

WIN METHODS BY WEIGHT CLASS

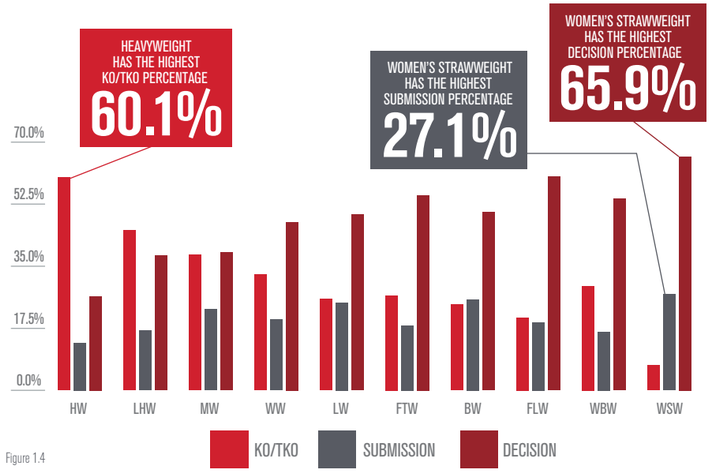


Figure 1.4

FINISH BY WEIGHT CLASS

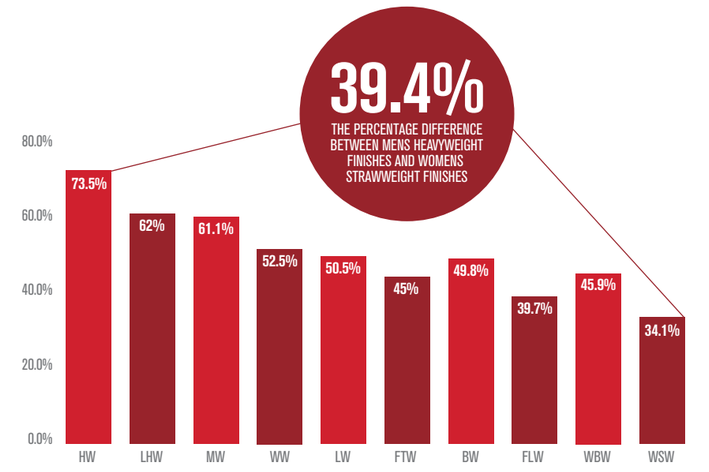


Figure 1.5

When examining fight finishes, obvious trends again become apparent—the heavier the weight class, the more likely a fight will be finished before going to the judges' decision (see figure 1.5). The vast majority of heavyweight bouts, 73.5%, are won by finish. By comparison, for 155lb lightweights 50.5% of fights are stopped, and for male 125lb flyweights the finish percentage is just 39.7%. Women's 115lb strawweights have the lowest finishing potential with only 34.1% of fights having a stoppage.

For all weight classes, the majority of fights that have a stoppage are finished by punches (45%; see table 1.1). Indeed, heavier weight classes—heavyweight (67.4%), light heavyweight (56.7%)—have a higher proportion of fights finished by punches compared with lighter weights—men's flyweight (39.3%) and women's strawweight (13.8%). From a submission perspective, rear-naked chokes (RNC) have produced the most finishes, (48.9%) followed by guillotine chokes. (25.3%) Strawweights have the highest incidence of RNC finishes (48.3%), while 145lb featherweights have the highest percentage of finishes by guillotine choke (11.6%).

FINISH TYPE BY WEIGHT CLASS (%)

WEIGHT	Punches	Elbows	Knees	Kicks	Armbar	Shoulder	Leg Lock	Other Lock	RNC	Triangle	Guillotine	Arm Triangle	Other Choke	Dr. Stoppage
HW	67.4	4.2	3.4	4.2	2.7	1.5	1.9	1.5	3.4	0.8	3.8	1.5	1.5	2.3
LHW	56.7	3.2	5.3	4.0	2.8	2.4	0.4	0.4	10.5	0.8	5.7	2.4	2.4	2.8
MW	41.9	5.1	4.8	6.6	4.0	1.4	1.7	0.6	12.0	5.1	10.0	3.1	1.1	2.6
WW	41.8	4.9	7.1	4.6	4.9	1.7	0.7	0.0	14.9	3.2	6.4	2.9	3.4	3.4
LW	33.9	2.5	3.3	6.8	5.5	1.5	1.0	0.0	23.4	4.5	9.5	1.3	3.8	3.0
FTW	49.0	2.0	4.8	2.0	2.7	0.7	0.0	0.7	14.3	4.1	11.6	1.4	4.8	2.0
BW	39.6	3.0	3.0	2.2	8.2	1.5	1.5	0.7	21.6	3.0	10.4	3.7	1.5	0.0
FLW	39.3	3.6	3.6	1.8	5.4	3.6	0.0	0.0	28.6	0.0	10.7	1.8	0.0	1.8
WBW	28.9	15.8	7.9	7.9	13.2	0.0	0.0	0.0	10.5	2.6	2.6	5.3	2.6	2.6
WSW	13.8	3.4	0.0	3.4	20.7	0.0	0.0	0.0	48.3	0.0	6.9	0.0	3.4	0.0

Table 1.1

WORK RATES – STRIKING

Worth consideration as a proxy of 'fight intensity,' strike frequency demonstrates the way in which the UFC has evolved technically and tactically in the past 16 years. In 2002, only an average of 4.25 strikes per minute were thrown during a bout. In 2017, the average has grown to 8.5 strikes per minute; representing a two-fold increase in striking frequency (see figure 1.6).

All female weight classes have higher strike rates than their male counterparts. When examining strike rates by weight class, the lightest weight classes, with the exception of male 125lb flyweights, have the highest strike rates per minute. Interestingly, heavyweights have an inverse relationship between a high number of finishes by KO/TKO (60.1%) yet the lowest strike rate per min (6.72). These data clearly reinforce the influence that impact force has on determining the outcome of heavier weight classes (see figure 1.7).

AVERAGE STRIKES ATTEMPTED PER MINUTE IN UFC

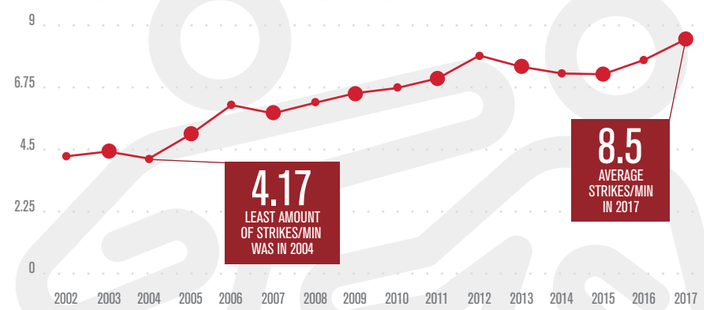


Figure 1.6

AVERAGE STRIKES ATTEMPTED PER MINUTE BY WEIGHT CLASS

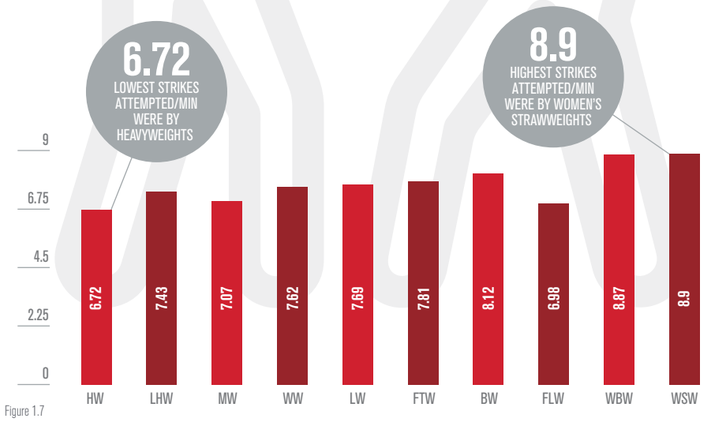


Figure 1.7

KEY PERFORMANCE INDICATORS

By adopting more powerful statistics, it is possible to define 'Key Performance Indicators' (KPIs) that impact each weight class. During each bout 167 individual fight metrics are recorded, analyzed, and evaluated against their respective importance to the final outcome of a fight. By ranking these variables, it becomes possible to distinguish the importance of different technical components (e.g. stand-up, takedowns, ground fighting). The top five variables which most impact winning, relative to the incidence with which they occur, are presented in table 1.2.

Variables relating to striking hold high rankings as KPIs for all weight classes. Indeed, the ability to execute striking techniques in an effective fashion is a critical aspect that directly influences success across all UFC weight classes. Elsewhere, controlling an opponent, be it on the feet or ground fighting, is of significance and also has a high effect on the probability of winning a fight.

In considering the KPIs relative to gender, both men and women rank 'total strikes landed' as the first variable that influences success (see table 1.3). Rankings of importance then become divergent between genders. Perhaps most notable, 'takedown success' percentage is ranked the third-most important indicator of success for females, whereas it is ranked 19th for males. It should be noted that these data do not show 'how' fighters win, but rather which metrics are 'related' to winning. While takedown success (%) is obviously of great importance, in this instance other metrics have a higher relationship to winning in males vs. females. 'Significant strikes landed' is 5th highest for men, but only the 10th most impactful variable for women. Also of interest when considering previous data that highlight the trend for increased striking rates in today's UFC, 'significant head strikes landed' is only the 15th and eighth-most important KPI for women and men, respectively.

KEY PERFORMANCE INDICATORS BY WEIGHT CLASS

	MEN								WOMEN	
	HEAVY	LIGHT HEAVY	MIDDLE	WELTER	LIGHT	FEATHER	BANTAM	FLY	BANTAM	STRAW
1	Strikes Landed	Strikes Landed	Strikes Landed	Strikes Landed	Strikes Landed	Time in Ground Control	Strikes Landed	Time in Ground Control	Strikes Landed	Strikes Landed
2	Sig. Strikes Landed	Time in Ground Control	Ground Head Stikes Attempted	Time in Ground Control	Time in Ground Control	Strikes Landed	Time in Control	Strikes Landed	Sig. Strike Success Rate	Strikes Attempted
3	Stikes Attempted	Time in Control	Strikes Attempted	Time in Control	Time in Control	Time in Control	Sig. Strikes Landed	Time in Control	Strike Success Rate	Sig. Head Strikes Laned
4	Sig. Head Strikes Landed	Sig. Stikes Success Rate	Sig. Strikes Landed	Sig. Stikes Success Rate	Ground Head Strikes Attempted	Sig. Strike Success Rate	Ground Control Time	Offensive Passes	Ground Head Strikes Attempted	Sig. Strikes Landed
5	Stike Success Rate	Ground Head Strikes Landed	Ground Head Strikes Landed	Sig. Head Strikes Landed	Sig. Strike Success Rate	Offensive Passes	Strikes Attempted	Sig. Strike Success Rate	Strikes Attempted	Ground Head Strikes Attempted

Table 1.2

KEY PERFORMANCE INDICATORS BY GENDER

KPI	IMPORTANCE RANK			MEAN (per minute)		
	ALL	WOMEN	MEN	ALL	WOMEN	MEN
Total Strikes Landed	1	1	1	5.5	6.2	4.9
Significant Strikes Success (%)	2	5	4	53	45	45.1
Total Strikes Attempted	3	2	7	10.4	11.6	9.2
Time in Ground Control (sec)	4	4	2	3.5	9.5	7.7
Significant Strikes Landed	5	10	5	3.8	4.2	3.4
Time in Total Control (sec)	6	7	3	12.8	14.1	11.5
Total Ground Head Strikes Attempted	7	6	6	1.8	2	1.7
Total Strikes Success (%)	8	12	16	45.1	53.3	52.6
Offensive Passes	9	8	11	0.1	0.1	0.1
Takedown Success (%)	10	3	19	43.2	46.3	39.5
Significant Head Strikes Landed	11	15	8	2.5	2.8	2.2
Total Ground Head Strieks Landed	12	9	9	1.4	1.5	1.3
Time in Miscellaneous Ground Control (sec)	17	30	10	8.6	3.7	3.3

Table 1.3

SEEKING TO UNDERSTAND THE RESPECTIVE COMPONENTS THAT INFLUENCE SUCCESS IS A FUNDAMENTAL PART OF DEFINING 'WHAT IT TAKES TO WIN'.

PRACTICAL APPLICATION

In summary, seeking to understand the respective components that influence success is a fundamental part of defining 'What it Takes to Win'. Working to distinguish 'determinants of performance' and the contribution they make is critical when working to identify trainable characteristics that coaches and athletes can improve upon in order to increase the probability of success. For this reason, the first step in any performance strategy is actually at the end! Put another way, clearly understanding the intricacies of the final competition should ultimately shape the steps an athlete takes to get there. It allows coaches to conduct a gap analysis between 'what is needed' and 'where their athlete is at currently,' and consequently question what improvements are needed to transcend the desired competition standard. UFC represents the most complex of sporting arenas. The data presented in this chapter provides insight into the way in which the sport of MMA has changed and evolved throughout the years, as well as defining what formulates competition in UFC today. Taking the first steps to understand the determinants of performance relating to these tactical aspects (e.g. win methods, KPIs) makes it possible to cascade understanding into additional technical, physical and psychological determinants in an accurate and intentional manner. Without knowing your destination, you have no direction!

CHAPTER ONE: WINNING IN TODAY'S UFC

QUICK TAKES

Average bout duration in UFC is **10 minutes, 43 seconds.**

- Heavyweights have the shortest bout duration **(8:02)**
- Strawweights have the longest bout duration **(12:35)**
- Each incremental weight class is on average 30.3 seconds longer **(3.3%)**

There is a relationship between weight class and finish percentage for men and women.

- **60.1%** of heavyweight fights are won by KO/TKO
- **60.3%** of flyweight fights go to decision
- Middleweight has the most even distribution of win methods (38.2% KO/TKO; 22.9% submission; 38.9% decision)
- **Rear-naked choke** is the most common submission finish

The number of average strikes attempted per minute **(8.5)** has doubled in the past 16 years, and continues to trend upward.

- Women's bantamweight **(8.87)** and strawweight **(8.9)** have the highest strike frequency per minute in UFC
- **72%** of the top 5 key performance indicators for all weight classes are related to striking techniques

CHAPTER TWO

MAINTAINING HEALTHY ATHLETES AND REDUCING INJURIES

INJURIES ARE OUR BEST TEACHERS

Prizefighting involves two athletes competing under distinct rules of engagement. However, due to the ferocity and aggressive nature of striking, takedowns, throws and submission attempts, combat sports like MMA are generally considered more dangerous and injury-prone compared with other athletic endeavors. To date, awareness of injury risk relating to preparation and competition has been lacking, and little is known about the primary injury risk factors pertaining to world-class UFC fighters. Gaining an understanding of the underlying mechanisms of injury as well as the nature and frequency with which they occur provides critical insight into injury characteristics. To best support the health and safety of UFC fighters, it is critical to generate accurate information that enhances our ability to minimize fight withdrawals due to injury, return athletes to the Octagon faster, and develop standards of care that minimizes injury risk for all UFC fighters.

ORTHOPEDIC PHYSICAL ASSESSMENT

Orthopedic evaluation provides an assessment of a) joint health, b) the presence of injury 'risk factors', and c) the status and/or extent of rehabilitation from prior injury. For example, athlete screening identifies deficits in functional movements that potentially predispose a fighter to increased risk of injury. Indeed, prior research shows that something as simple as a greater than or equal to **10% bilateral asymmetry in a functional measure can increase injury risk by 70-90%**. In addition to evaluating injury risk, orthopedic evaluation (i.e. functional movement assessment) can also improve performance standards inside and outside of the Octagon. UFC fighters are associated with a higher risk of specific joint or muscle injury, therefore orthopedic evaluation seeks to gain more understanding of an athlete's predisposition to MMA injury. Evaluations should include:

- Range of motion (ROM)
- Posture
- Joint stability/instability
- Functional strength/weakness
- Weight-bearing mechanics
- Neurological symptoms
- Breathing patterns
- Past injury history

Functional mobility is a fundamental component of muscle, joint and connective tissue health, and in many situations a reduced or excessive ROM can be identified as an injury predictor. Indeed, owing to the requirements of MMA techniques, the habitual biomechanical posture that combat sports can influence, and the effect that historical injury can have on long-term joint health, MMA fighters can be significantly affected by basic functional asymmetries that can ultimately present as large-scale injury problems. Table 2.1 presents normative values for UFC fighters (n = 223; approximately 40% of the UFC roster) compared to other non-combat elite athletes.

UFC FIGHTERS VERSUS NON-COMBAT ATHLETE NORMATIVE VALUES FOR RESPECTIVE ORTHOPEDIC EVALUATION VARIABLES

BODY PART	FUNCTIONAL ASSESSMENT	UFC FIGHTER AVERAGE (RANGE)	ELITE ATHLETE NORMS
FOOT	Navicular Drop (arch of the foot)	5.1mm (1 - 17)	≤6mm
ANKLE	Total ROM	41.2 (19 - 66)	≥35 °
HIP	Extension ROM	11.2 ° (27 - 24)	≥15 °
	ROM (Internal + External)	99.2 ° (57 - 201)	≥90 °
SHOULDER	Flexion ROM	173.8 (155 - 181)	≥180 °
	Abduction ROM	176.7 (146.5 - 189)	≥180 °
	Internal rotation ROM	60 (40 – 89.5)	≥70 °
	External Rotation ROM	110.85 (73.5 – 150)	≥90 °
CERVICAL SPINE	Flexion ROM	43.6 (15 – 68)	≥45 °
	Extension ROM	54 (20 – 86)	≥55 °
	Rotation ROM	68.3 (40.5 – 99)	≥70 °

Table 2.1

EVALUATION OF STANDARDS

Average values for UFC fighters indicate that many athletes have a large navicular drop, or collapsed arch of the foot, in some cases up to 17mm. Issues such as this can significantly affect an athlete's ability to generate power off the canvas, and not only lead to potential biomechanical issues but also sub-optimal performance in key technical maneuvers (e.g. kicks and knee strikes, movement and change of direction).

Elsewhere, ankle range of motion appears very good in UFC fighters, yet hip extension is poor. Indeed, with a ROM of 15 degrees defined as 'normal range', the 11.2 degrees average found in UFC fighters shows a predisposition to tight hip flexors. There are potentially a number of underlying mechanisms that influence this (e.g. the regularity with which the hip flexors are used in throwing kicks and knees), yet the negative impact that this condition creates is primarily the development of an anterior pelvic tilt, where the shortened hip flexors pull on the pelvis at their attachment. Anterior pelvic tilt, as we discuss later in this chapter, can lead to exaggerated lower back pain and complications with standing posture.

Perhaps the biggest area that presents as predisposed to injury in UFC fighters from the orthopedic evaluation is the shoulders and cervical spine region. Normative values for shoulder ROM in UFC fighters are very poor when compared with other non-combative elite athletes. To compound this lack of shoulder range, a high incidence of restricted cervical spine (i.e. neck) mobility is also found in this population. It is likely that limited shoulder and neck ROM is a consequence of the defensive guard position fighters chronically adopt during stand-up (gloves held high to the chin, and shoulder internally rotated to minimize an opponent's target). However, severe limitations in the ability of the neck and shoulder girdle to move freely can lead to both under performance in upper-body striking as well as potential injury risk if or when the neck or shoulders are forced to move through a greater ROM than they are capable of during grappling and submission attempts.

INJURY INCIDENCE

Identifying the nature and frequency with which injuries occur is critical in order to direct preventative programs that target the specific causes and types of injury encountered in the UFC. Baseline assessments, injury histories, and tracking medical suspensions have all been conducted to provide a platform that allows us to better understand the characteristics of both training and competition injuries occurring between June 2017 and June 2018. The UFC Performance Institute has treated over 220 individual fighters for medical conditions and delivered close to 2,000 daily treatments in 12 months; including medical services to 138 UFC fighters remotely at pay-per-view events around the world.

In 12 months, 322 injuries were treated, with the majority of injuries reported (n=248) sustained during competitive fights. This reflects 77% of injuries being caused during a competitive fight. In stark comparison, only 33 injuries were training-related (10.2%), 3 were caused during strength and conditioning activities (0.9%), and 38 were classified as 'other' (11.8%); which includes historical injuries, overuse injuries, or incidental non-MMA-related injuries ***(n.b. it should be noted that these data are likely skewed with respect to the reporting of training vs. competition injuries. It is likely that the majority of training-related injuries go unreported to the UFC database and therefore are not appropriately reflected in this statistic).*** The average duration for injuries is presented in figure 2.2. Fight-related injuries have an average duration of 63 days before they are resolved. Injuries suffered during training have a rehabilitation time frame of approximately 53 days.

INJURY INCIDENCE DISTRIBUTION

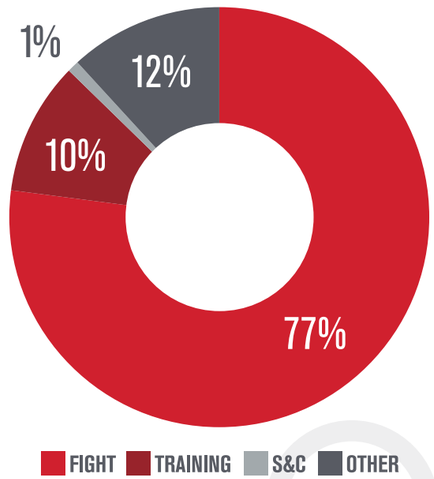


Figure 2.1

AVERAGE INJURY DURATION (DAYS)

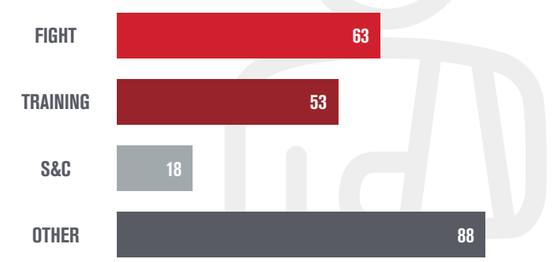


Figure 2.2

INJURY MECHANISMS

Knowing the distribution of injuries and when they occur (e.g. competition, training) is critical in order to define strategies that can be adopted to minimize the risk of them occurring. However, in a combative sport such as MMA, where injuries are inevitable, understanding the mechanisms by which they occur is central to providing supporting efforts that maintain athlete health. This then has an influence on the training-competition spectrum, and can include considerations such as when to wear body armor and protection, how to match up training partners safely, the distribution and number of athletes training on a mat area during practice, and high-level considerations around workload management and periodization.

At the most basic level, injury mechanisms can be separated into clearly defined categories: grappling, striking, submission, unknown (which includes fighters being unable to recall whether an injury was training- or competition-related), or other mechanisms (e.g. injury during non-specific physical activity). The distribution of injury mechanisms are presented in table 2.2. The primary ways injuries happen in training and competition are then shown in table 2.3.

When filtering the specific incidences of injury and the mechanisms by which they occur, be they in training, during a fight, or via other mechanisms, we gain great insight into how injuries happen and the stimuli that potentially hold the greatest injury 'risk' (i.e. straight jab). From our early findings with respect to the frequency at which injuries occur, striking techniques present the highest injury risk. Indeed, by grouping elbows, hooks, jabs, kicks and generic 'striking' together, it accounts for 36.5% of all injury mechanisms. The 'jab' mechanism alone represents 10.8% of all injuries. Alarmingly, nearly 30% of injury mechanisms are not directly related to MMA training and conditioning, but instead occur through methods outside the professional activities of UFC fighters.

From a severity perspective, grappling and takedowns represent the highest-risk mechanisms to fighters. Those injuries suffered during takedowns or unstructured and chaotic ground fighting have an exaggerated average injury duration of 112 and 129 days, respectively. Worth noting, overuse injuries average 50 days time-loss, and such injuries are largely preventable. The time loss from overuse represents an injury statistic that should not even be a consideration if appropriately managed training is applied to an athlete.

COMMON FIGHT AND TRAINING INJURY MECHANISMS

FIGHT	
MECHANISM	INJURY DISTRIBUTION (%)
GRAPPLING	7.6
SUBMISSION	0.8
STRIKING	64.9
UNKNOWN	26.6

TRAINING	
MECHANISM	INJURY DISTRIBUTION (%)
GRAPPLING	6
SUBMISSION	39.3
STRIKING	45.4
UNKNOWN	9

Table 2.3

INJURY DISTRIBUTION BY ACTIVITY

ACTIVITY	INJURY DISTRIBUTION (%)	AVERAGE DURATION OF INJURY (DAYS)
GRAPPLING	6.7	86
SUBMISSION	5	40
STRIKING	55	59
UNKNOWN	32	73
OTHER	0.3	143

*N.B The injury duration for 'other' is heavily skewed due to the low number of incidences but the severity of these injuries.

Table 2.2

INJURY DISTRIBUTION BY MECHANISM

ACTIVITY	INJURY DISTRIBUTION (%)	AVERAGE DURATION OF INJURY (DAYS)
BLOCKING	0.3	30
ELBOW	0.3	54
HOOK	6.5	53
JAB	10.8	58
KICK	4.0	48
KICKS BLOCKED	5.9	58
POSTING	0.3	41
SLAM	0.6	45
'STRIKING'	14.9	44
TAKE DOWN	0.3	112
UNKNOWN	14.2	91
CHRONIC	1.8	32
GRAPPLING	2.8	129
OVERUSE	2.4	50
SUBMISSION	4.3	42
CONDITIONING	0.9	18
CONTACT WITH FLOOR	0.9	61
OTHER	28.2	76

Table 2.4

INJURY TYPES

The types of injuries that fighters suffer are highly variable in nature. Due to the wide variety of mechanisms that cause injury, it is perhaps normal to expect that the types of injury encountered would also present in very different fashions. Table 2.5 shows a comparison of the five most common injuries suffered during training and competition. Head and face injuries make up over 75% of fight injuries (including concussion), while the knee is twice as likely to be injured during training than the next most injured body part, the shoulder.

The complete distribution of injuries by body region is shown in figure 2.3. It is clear that the head/face, shoulder, wrist/hand, knee and foot are the primary areas getting injured, but additional areas are exposed to injury as well.

Relative to each injured body part, an awareness of the detailed classification of injury further increases our accuracy of understanding. Figure 2.4 on page 26 details each primary body part that sustains injury among UFC fighters, and presents the injury diagnosis distribution accordingly.

MOST COMMON FIGHT AND TRAINING INJURIES BY RANK

FIGHT		
RANK	MOST COMMON	INJURY DISTRIBUTION (%)
1	HEAD/FACE	77.8
2	WRIST/HAND	19.5
3	KNEE	15.6
4	FOOT	10.7
5	SHOULDER	9.7
6	LOWER LEG	5.3
7	ELBOW	4.8

TRAINING		
RANK	MOST COMMON	INJURY DISTRIBUTION (%)
1	KNEE	37
2	SHOULDER	18.5
3	WRIST/HAND	14.8
4	NECK	7.4
5	FOREARM	7.4
6	ELBOW	7.4
7	ANKLE	7.4

Table 2.5

INJURY DISTRIBUTION BY BODY PART

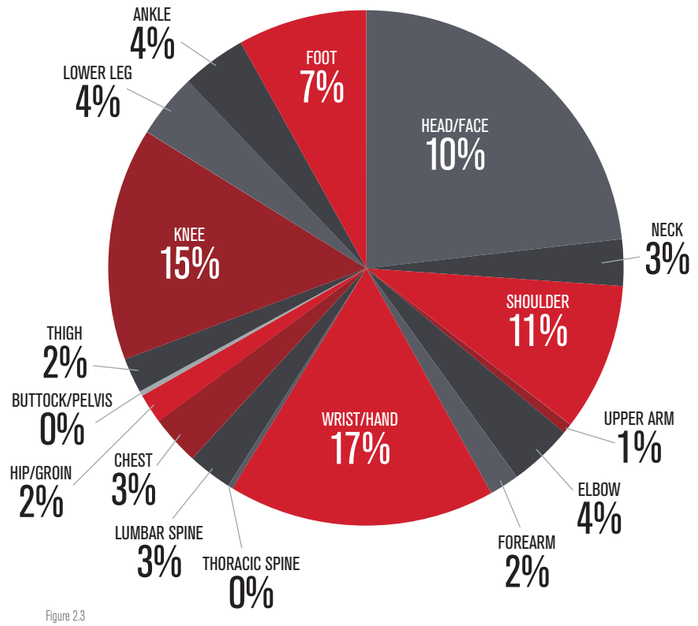


Figure 2.3

INJURY DISTRIBUTION BY BODY PART

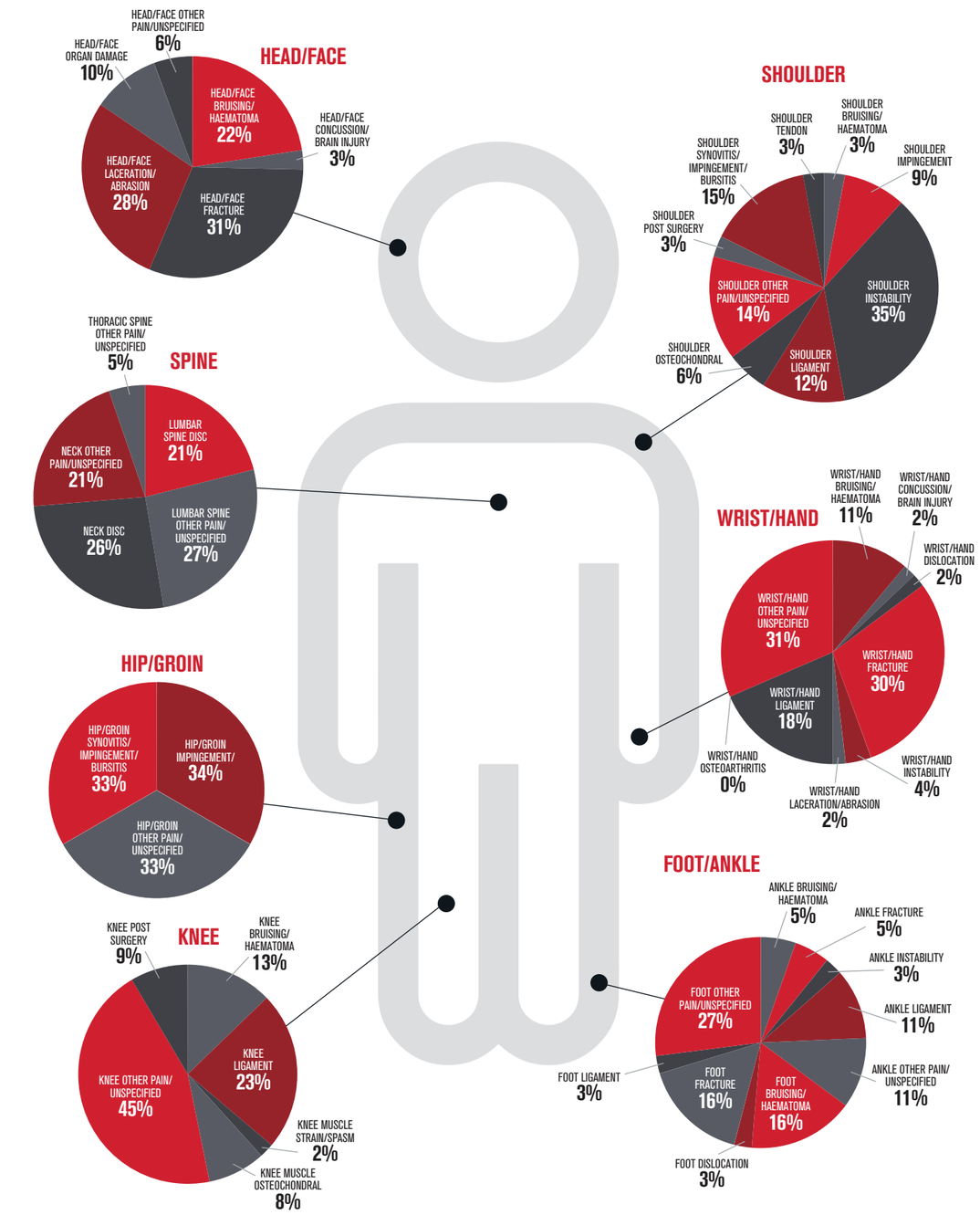


Figure 2.4

INJURY PREVENTION

By working to fully understand injuries, the mechanisms by which they occur, and the body parts most prevalent to injury, it is hoped that the UFC Performance Institute and MMA coaches can turn their attention to injury prevention strategies in an effort to be more intentional in supporting acute and chronic athlete health. The power of insight that this injury audit data provides allows us to now ascertain the top five areas of injury in UFC:

1. Head
2. Knee
3. Wrist/Hand
4. Shoulder
5. Foot

We also now know, through our orthopedic evaluations, that UFC fighters are predisposed to defined biomechanical and postural insufficiencies. Typically, MMA fighters have a pronounced 'forward posture' (i.e. forward head, forward shoulders, thoracic kyphosis, tight pecs and anterior cervical muscles, protracted scapulas, anterior tilted pelvis or lumbar lordosis, significant tightness in hip flexors and weak glutes, poor breathing patterns and weak lower abdominals). The extent of these biomechanical insufficiencies and asymmetries offers great potential to address injury prevention with simple complementary approaches that are strategically directed and influence population norms.

As a result of our insights, we believe there is now more clarity as to the best approach to proactively work to influence the robustness and resilience of UFC fighters against injury. Combining the top injured body parts, clinical assessments, and the overall nature/technique of MMA fighters, we can now define preventative programs deemed effective for improving health and performance.

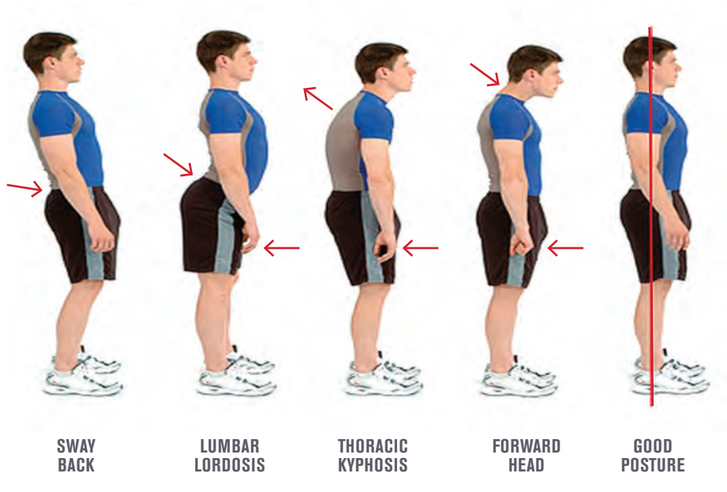


Figure 2.5

UPPER BODY

Training and competition for MMA inherently creates poor posture and muscle imbalances. Postural correction should be the starting point for any remedial approaches when not performing MMA-related activities. This should largely start with efforts to elongate the anterior shoulder musculature (i.e. pecs and anterior neck), strengthen the posterior musculature (i.e. rotator cuff, rhomboids, and middle/lower traps), and improve scapular control. Supplementary training (i.e. strength and conditioning, physical therapy) should work to intentionally correct biomechanical insufficiencies that can be considered the foundation of injury prevention.

LOWER BODY

Many lower-body issues (hip and knee) can be rooted back to the anterior pelvic positioning so prevalent in UFC fighters. Many fighters have a habitual anterior pelvic tilt that is coupled with very poor levels of glute or lower abdominal strength and control. Chronic exposure to this posture/position leads to back, hip and knee issues as a direct consequence of increased lumbar lordosis and changes in hip mechanics that cause stress/forces to be placed on the joints above and below the hip. By creating more mobility in the front hip musculature, remedial-level strengthening of the posterior chain, and introducing lower core-activation, many of the issues stemming from this incorrect biomechanical position can be alleviated. Indeed, correcting an anteriorly rotated pelvis allows fighters to begin to use the correct larger muscles to generate and absorb forces the way they were designed. Consequent to improving hip and knee positioning, while also increasing proper lumbar stabilization, it is possible to then address injuries that resonate from the lower back and down the posterior kinetic chain.

CHAPTER TWO: MAINTAINING HEALTHY ATHLETES AND REDUCING INJURIES

QUICK TAKES

≥10% bilateral asymmetry in a joint or muscle group can increase the risk of injury by 70-90%.

Orthopedic evaluation represents an effective way to identify underlying contraindications that may predispose an athlete to heightened injury risk.

1. A 11.2-degree average hip flexor ROM found in UFC fighters shows a predisposition to tight hip flexors
2. As a population, UFC fighters present significantly compromised shoulder flexion and abduction ROM compared with non-combat elite athletes

Striking techniques have the highest injury risk by frequency, accounting for 36.5% of all injury mechanisms.

Takedowns and grappling have the highest injury severity risk in terms of average injury duration.

Preventable overuse injuries average 50 days of time-loss.

Head and face injuries make up over 75% of fight injuries (including concussions).

The top five areas of injury in UFC are:

1. Head
2. Knee
3. Wrist/Hand
4. Shoulder
5. Foot

CHAPTER THREE

OPTIMIZING THE TRAINING PROCESS

TRAINING IS KNOWLEDGE TRANSFER, DESIGNED TO FUTUREPROOF THE BODY

The fundamental goal of training is to consistently produce **maximum performance** while **avoiding injury**, minimizing **overtraining**, and reducing the negative side effects of **residual fatigue**. Due to all the respective components that go into MMA training (e.g. striking, grappling, wrestling), UFC fighters can be at risk of the inadequate application of training loads and lack of recovery. In addition, by often trying to achieve maximum results in a short timeframe (e.g. short-notice fights), fighters can also get caught in the trap of "the more (load), the better."

The result of this vicious cycle of 'maximum work followed by suboptimal recovery' is that ensuing training sessions are compromised, athletes are unable to perform at the desired level, development is negated, and there is a heightened risk of injury. Consistently training in a state of fatigue (i.e. non-recovery) leads to chronic stress, overtraining, under-performance, illness and injuries.

Athletes who are challenged trying to maximize the 'transfer of their training' to performance show very clear trends in the mechanisms that lead to under-performance:

- Poor planning of workload distribution throughout the training week.
- Ineffective preparation processes that result in high physiological 'cost'.
- Lack of daily planning that is based on objective feedback relating to key physiological parameters.
- Neglect of adequate recovery and regeneration processes (e.g. nutrition, sleep, recovery modalities).

DAILY 'READINESS'

The *'functional state'* of an athlete describes the short- and long-term responses to training load and their ***'readiness'*** to adaptation in response to training stimuli. Readiness determines an athlete's ability to realize his or her capacity/potential in training or competition. Deviations from *optimal* readiness should be regarded as potential signs that an athlete is starting to show the inability to tolerate the demands of a planned training load.

Figures 3.1 and 3.2 show 'readiness' data from a UFC fighter; collected using Omegawave. Omegawave is a technology that takes measurements relevant to an athlete's physiological condition; including heart rate variability, the brain's control of the central nervous system, and ECG analysis of the cardiac system. Figure 3.1 clearly shows a trend throughout April for increased physiological stress levels that are close to being outside of the desired range. This elevated stress is associated with a reduced recovery pattern, as shown in Figure 3.2. In combination, elevated stress and reduced recovery can have a significant detrimental effect on performance standards.

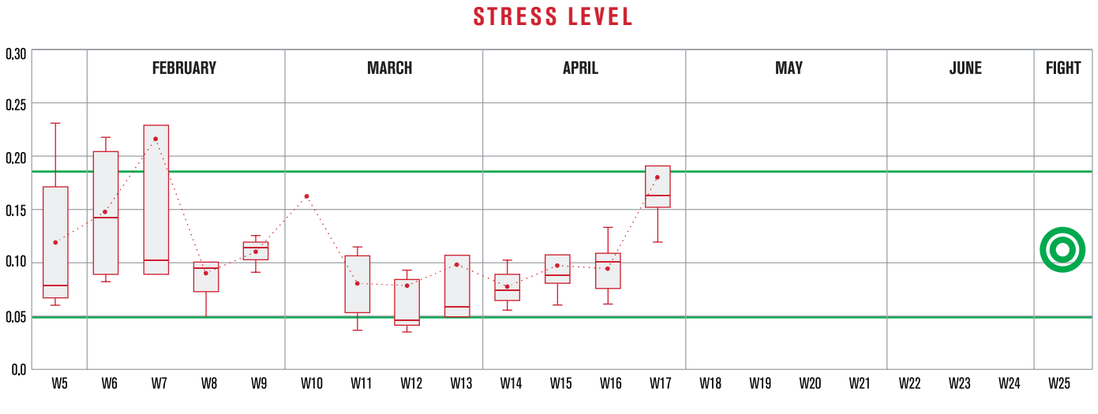


Figure 3.1 Trends in the 'Physiological Stress' response to training load over time for Athlete X. The 'normal' stress response to training should be within the green boundary; above the boundary indicates high arousal stress levels, whereas below the boundary indicates suppressed stress levels. From this figure it can be seen that the current trend for this athlete is of concern and indicates heightened stress levels that are close to being outside the desired optimal range.

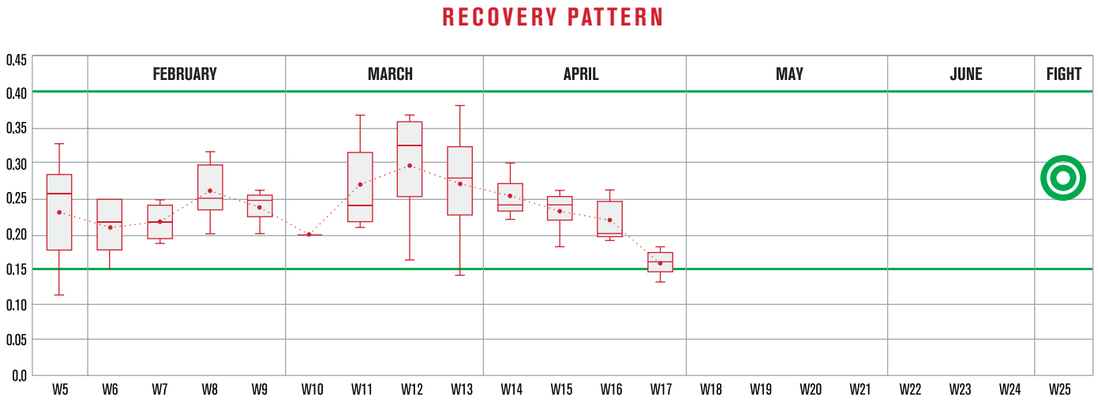


Figure 3.2 'Physiological Recovery' response for Athlete X. In associate with figure 3.1, which highlights heightened stress levels with training load, the trend for reduced recovery is shown here. This negative trend is of great concern as it indicates under recovery in response to the ongoing training demands.

'TRAINABILITY'

Trainability is the capacity to receive training loads (input) and effectively adapt to them (process), thereby producing a positive training effect (output).

Input is everything thrown at the athlete. It represents the stress load of all training units and how hard they are pushed during those sessions. ***Output*** is the athlete's response to a previous input. When training load is managed well, a certain *input* should always lead to a certain *output*. When not managed well, an *input* has a detrimental effect, rather than a positive effect, which can accumulate if the *input* continues.

Every athlete at every point in time has a unique internal environment. To keep it simple, this unique functional state is like a 'stress reservoir.' Sometimes that reservoir is full; sometimes it's empty.

Depending on the internal environment during the time of training, the athlete's response will be different. Sometimes, the same workout might leave the reservoir ***empty*** (this training had a 'high cost'); other times, the same workout can leave it ***full*** (this training had a very 'low cost'). This is the ***'cost of training'*** or the ***'cost of performance.'***

- **Window of Trainability** – a period of time, based on the current functional state of the athlete, during which a decision needs to be made whether to apply a training load, reduce a training load, or remove it entirely.

- **Open Window of Trainability** – a period of time when the application of a training load will lead to positive adaptations, and thus improved athletic performance. An open window of trainability allows for the application of workouts with a 'high cost'.

- **Closed Window of Trainability** – a period of time when the body is in a state of imbalance, reduced function and/or fatigue that reflects a lack of 'readiness' for particular training loads. In this instance 'low cost' workouts would perhaps be more beneficial.

The UFC Performance Institute is now supporting athletes remotely around the world to better optimize their response to training, allowing them to train more effectively and efficiently, and to ultimately maximize their performance. We have the ability to help any UFC fighter find the most favorable time and preferable condition in which to develop their level of preparedness and sport mastery; including endurance, speed & power, strength, and coordination & skill.

PRACTICAL APPLICATION

All things being equal, Athlete A has fully 'open' windows of trainability for developing all physical qualities. (see the green lights for Endurance, Speed & Power, Strength, and Coordination & Skill in figure 3.3 below). In training, Athlete A performs exercises with maximal loads and intensities. Their body is able to process the load and create a positive adaptation, thus improving their performance results.

Athlete B has a 'closed' window of trainability for developing Strength, Speed & Power and partially closed windows for Endurance, and Coordination & Skill. (see figure 3.4) However, they are unaware of this and perform the same team training as Athlete A, with maximal loads and intensities. Their body is not able to process the load and gain useful adaptations because the process of adaptation to previous loads is incomplete. Consequently, not only did they fail to improve their results, but having to compensate for this state of poor 'readiness,' the cost of training for Athlete B was higher than for Athlete A.

Figure 3.3 Athlete A can maximize the training response using 'windows of trainability'

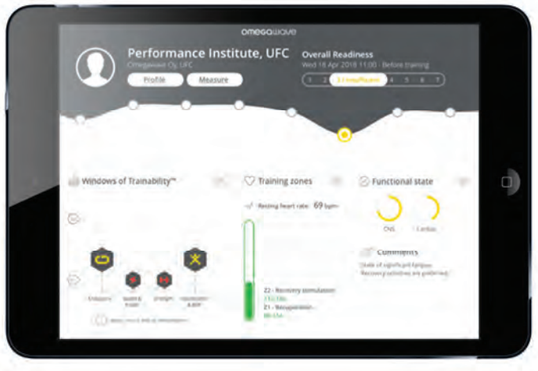


Figure 3.4 Athlete B shows a suppressed training response using "windows of trainability"

CHAPTER THREE: OPTIMIZING THE TRAINING PROCESS

QUICK TAKES

Preparedness – the multifaceted, cumulative state of a fighter, composed of specific developmental factors including sport-specific skills, physical and psychological.

Readiness – the current functional state of an athlete that determines his or her ability to achieve their performance potential.

Cost of Adaptation – the physiological cost an athlete's body pays for adapting to training and nontraining-related stimuli.

Training Load – a specific amount of training stimulus applied to the athlete in order to provoke crucial adaptations in the sport-specific functional system.

Overreaching – a *temporary* state of fatigue that occurs in response to high and intense loads, without allowing time for sufficient recovery. Characterized by sleep disturbance, mood instability and a short-term decrease in performance capability.

Overtraining – a chronic state of exhaustion. This is a pathological state caused by repeated, prolonged, high-intensity, high-volume and monotonous loads without allowing time for sufficient recovery. This state is primarily characterized by prolonged underperformance.

Window of Trainability – *a period of time*, determined by the current functional state of the athlete, during which a decision needs to be made whether or not to apply a particular training load that is designed to lead to useful adaptations and improve athletic performance.

- **Open Window of Trainability** – a period of time when the application of a particular training load will lead to positive adaptations, and thus improved athletic performance.
- **Closed Window of Trainability** – a period of time when the body is in a state of imbalance and reduced function, reflecting a lack of readiness for particular training loads.

CHAPTER FOUR

MANAGING THE TRAINING PROCESS

PLAN YOUR WORK, THEN WORK YOUR PLAN

Periodization refers to a systematic approach to sports training. The goal of periodization is to increase the probability that all skill-related and physical qualities peak for competition within a specific time frame. Essentially, periodization is the process of planning training by strategically cycling different training demands at appropriate times to ensure recovery from and adaptation to previous training stimuli.

Every fighter responds in a unique and individual way to the stresses associated with training. Physiologically, the response to physical stress (i.e. MMA training, strength and conditioning) can be described by a model known as the General Adaptation Syndrome (GAS). The GAS model is broken into three stages of responses to training stress:

Alarm Stage – initial 'shock' to the system induced by a stimulus
Resistance Stage – 'adaptation' of the system as it becomes accustomed to the stimulus
Exhaustion Stage – inadequate 'repair' to the system, which results in decreased adaptation and performance

By managing training load using a progressive/cyclic/periodized approach, it is possible to maximize the time spent in the **resistance** stage without ever reaching the **exhaustion** stage. The resistance stage is where all beneficial adaptations to training take place, and it is within this stage that true physical and performance gains are made! If, however, an athlete is exposed for too long to excessive or prolonged exposure to the same training stimulus (e.g. over-training), he or she can move into the exhaustion stage of the GAS model, where residual fatigue is high, performance is compromised, and the opportunity for any beneficial adaptation is largely negated.

Periodization models are useful as they offer vast amounts of flexibility, adaptability and organization that can be tailored to individual coaching philosophies and approaches. At the same time however, they consider how the body optimizes skill acquisition and physiological adaptation according to basic scientific principles.

In traditional seasonal athletic events, planning and periodizing your training and competitions can be fairly easy, as competitions are largely scheduled ahead of time and there is always an awareness of the dates and time-frames that an athlete is working toward. Once competition schedules are laid out, practitioners and coaches can simply plug in periodized schemes—for sport-specific training, fueling, supplementary conditioning activities, and recovery—around the competitions. In stark contrast, professional MMA poses a problem for that style of planning, as fights are scheduled one at a time for promotional/match-making purposes, and there is often little awareness as to the time period between fights. For this reason, UFC fighters and coaches need to have an effective planning process that is less ridged and more adaptable. It should facilitate their ability to organize development during longitudinally progressive training blocks but at the same time prevent fighters becoming too far removed from fight-specific standards so they have the ability react to short-notice fight opportunities when a date gets offered.

PERIODIZATION FUNDAMENTALS

Periodization of training is built around the premise that the 'distribution' of training loads and intensities has the most beneficial impact on the physiology of an athlete. For this reason, when managing daily, weekly or even monthly training loads, it is important to maintain a balance between when the physiology should be placed under high stress and when that demand should be reduced slightly in order to allow for recovery, regeneration and adaptation. At the most fundamental level, defining high-, moderate- and low-intensity training days is a simple way to manage fatigue and ensure windows of recovery are available in order to spring-board an athlete on to the next training intervention. An example of periodizing a training week to get balance between the time an athlete is placed under high training stress and the time given to recovery may look like this:

Figure 4.1

OBJECTIVE ASSESSMENT

Assessment of key physical qualities and attributes prior to employing any training process is a necessity. Without assessment, a coaching team is unable to have any objective awareness of regression or progression when it comes to the individual analysis of the athlete. Indeed, without an approach to gaining objective data that identifies where an athlete is excelling or where they are under-performing, it ultimately becomes guess work as to the best approach to take in order to improve an athlete's performance. *'Guess work and luck probably doesn't strike you as the best way to achieve a World Championship!'*

Assessments designed to evaluate overall physical performance characteristics should be performed prior to 'off camp' training. Assessment should also be performed during the first week of fight camp during the initial stages of the performance plan. A mid-camp assessment and peak-camp assessment are ideal for monitoring the developmental progress of the athlete leading up to a fight. This information can also be used to refine individual training systems for future fight camps.

PERIODIZATION FOR MMA

In the most simplistic terms, UFC fighters can be defined as being either **"Off Camp,"** in which they currently have no fight scheduled, or in **"Fight Camp,"** when they have a set fight date and are preparing accordingly. The UFC Performance Institute advocates a system of periodizing training for MMA athletes that flexes to account for these two phases and ultimately provides a framework that optimizes the opportunities for performance enhancement within each.

"OFF CAMP"

When athletes are "Off Camp," a **sequential linear block style** of planning is implemented. This sequential method uses specific intervals of time in order to develop a singular goal (e.g. explosive strength, lactate tolerance). Throughout each focused block, there is a basic increase in training intensity with a concurrent decrease in training volume over time. One of the values of the sequential block approach is that it can be used away from competition to truly impact individual needs and requirements. For example, long linear blocks or short linear blocks can be adopted. Longer linear blocks (4-6 weeks) work well for general fitness, in the rehabilitative setting, or when a fighter has a clear physical quality that needs focus and sustained training in order to improve. Short linear blocks can be more about fixing any shortcomings or maintaining a performance attribute at a desired standard, and usually last 2-3 weeks.

The "Off Camp" training is periodized into two discrete preparatory stages; Phases 1A-General and 1B-Specific. The **"Off-Camp-General Preparation"** phase is most important for the development of underlying physical qualities and the drilling of fundamental MMA skills. Phase 1B is an extension of 1A, but the focus is modified slightly to **"Off Camp-Specific Preparation"**. Phase 1B ensures fighters continue to get small amounts of exposure to higher-quality 'specific' preparatory work that maintains fighting skills. Based on assessment metrics, "Off Camp-General Prep" can prioritize mobility, stability and proprioceptive qualities, along with overall work capacity in the realms of strength and aerobic endurance. "Off Camp-Specific Prep" can begin the process of addressing qualities such as muscular power, along with energy system development involving alactic power, and anaerobic/glycolytic capacity (see figure 4.2).

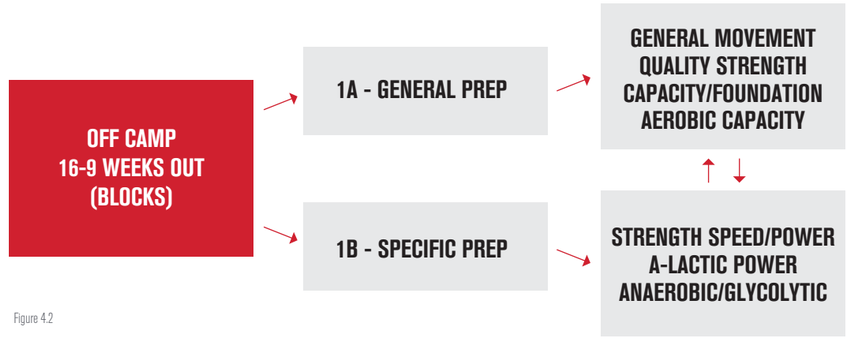


Figure 4.2

"Off Camp" blocks tend to be composed of four microcycles (stages/weeks): ***Introductory, Accumulation, Peak and Deload*** (see figure 4.3). The emphasis and objectives of the daily regimens remain the same during "off camp" linear blocks. Each micro phase progresses as the descriptions below imply:

Figure 4.3

Introductory. As the name would imply, this microcycle is about introductory volumes, intensities and methods according to the training age of the athlete and overall block emphasis. Introductory weeks can also serve as the perfect opportunity to re-evaluate certain physical qualities via objective testing and assessment.

Accumulation. This microcycle refers to a progressive increase in volume load, a complementary increase in intensity of said load, and increased sports specificity and athletic complexity of the training methods employed.

Peak. The most physically demanding week of the training block. This is where the convergence of volume, intensity and technical difficulty reach their climax.

Deload. This microcycle represents the transition period between blocks. It is an opportunity to reduce training volume in order to stimulate a recovery effect and allow the athlete to avoid the exhaustion phase of GAS. While volume is reduced, it is important to maintain or slightly increase the work intensity to ensure continued progress into the next training block. These Deload weeks can also serve as opportunities to strategically re-assess certain physical qualities.

"FIGHT CAMP"

"Fight Camp" training is largely defined as the **Realization phase** (see figure 4.4). The Realization phase for MMA fighters prioritizes the conversion of newly acquired increases in strength/force production from the preparatory periods into maximum speed, peak power, increased rate of force development (RFD), and optimized metabolic condition that specifically meets the demands of the fight. This phase is commonly 10-4 weeks out from fight day.

During the **"Fight Camp"** phase, the UFC Performance Institute implements a shift away from sequential linear block periodization and utilizes a **daily undulating periodization scheme**. Within the undulating method, multiple training stimuli are rotated between workouts over a weekly cycle, thus allowing the ability to target a variety of performance outcomes at the same time. As a priority, the day on which any physical training stimulus occurs is ultimately determined by the way it complements the daily MMA training regimen. Figure 4.5 shows a brief example of daily undulation within one microcycle.

An important consideration for the **"Fight Camp"** training phase is the addition of a recovery week just prior to the peaking stage of camp. This can effectively occur four weeks out from the fight, and the acute reduction in any supplementary training volume can again assist in keeping the fighter out of the exhaustion phase of the GAS, and instead maintain them in the resistance stage throughout the upcoming peaking phase of camp.

FIGHT CAMP 10-4 WEEKS OUT (DAILY UNDULATING)	=	**REALIZATION**	= **MAXIMUM STRENGTH** **DYNAMIC STRENGTH/ PEAK POWER** **SPEED/ALACTIC POWER** **ANAEROBIC/GLYCOLTIC CAPACITY**

Figure 4.4

DAY 1	**POWER PEAK** - MOD/ HIGH RESISTANCE HIGH RATE OF FORCE DEVELOPMENT *FULL RECOVERY*	**A-LACTIC CONDITIONING** - MAX EFFORTS <10 SEC OF WORK 1X12 *FULL RECOVERY*
DAY 2	**RESISTANCE CIRCUIT** - 5 EXERCISES (40-60%) 5 X 20 SEC / 20 SEC *1 MIN RECOVERY BTW ROUNDS*	**GLYCOLTIC CONDITIONING** - 3 X 30 SEC (2 MIN ACTIVE REC) *5 MIN REST* 90 SEC (3 MIN ACTIVE REC) *5 MIN REST*
DAY 3	**MAX STRENGTH** - 6 X2 @85-95% *FULL RECOVERY BTW SETS*	**AEROBIC DEVELOPMENT** - CONTINUOUS RUN OR BIKE 10 MIN - HR 120-140 25 MIN - HR 155-165 10 MIN - HR 115-130

Figure 4.5

PEAKING AND TAPERING 2 WEEKS OUT	=	**REDUCE TRAINING FREQUENCY** **REDUCE TRAINING VOLUME** **MAINTAIN TRAINING INTENSITY**

Figure 4.6

"LATE CAMP" (PEAKING & TAPERING)

The ***Peaking & Tapering phase*** involves the last two weeks of fight camp and employs a progressive reduction in training volume. This is a reduction in the overall work volume executed by reducing the number of sets, reps, drills or frequency of training sessions.

ORGANIZING THE MOVING PARTS

A fight camp requires athletes and coaches to balance all the respective components that go into their preparation. Indeed, MMA represents the "decathlon of combat sports," with every component as important as the next in the way it can ultimately shape and contribute to success. For the performance team to organize harmonious microcycles (weekly) and mesocycles (monthly) of training, at the UFC Performance Institute, fighters and fight teams are asked to provide information that is critical for shaping successful training. This information is gathered via a consultation questionnaire like the one below. This is an example of a fighter seeking remote programming after an initial on-site consultation at the PI.

UFC PERFORMANCE INSTITUTE

S&C CONSULTATION

NAME	Soda Popinski
WEIGHT CLASS	Light Heavyweight
CURRENT BW	232 - Recommend getting weight down to stay ready (220)
AGE	31
IN/OUT CAMP	Out
FIGHT DATE	None
WEEKS OUT	None
LOCAL OR REMOTE ATHLETE	Remote
INJURY HISTORY	Left shoulder Labrum
PT CONSULTATION	Full ortho screen with UFCPI PT Staff
HOMEWORK	Shoulder Labrum Rehab Program (check w/PT Staff)
NUTRITIONAL CONSULTATION	Meet with Director of Nutrition (metabolic efficiency, RMR)
HOMEWORK	Nutrition Plans
	Daily Recall, follow up phone call, scheduled for 4/12/18
$V0_2$ MAX CONSULTATION	Meet with Director of Sports Science
4mm Lactate	Reached during stage 2 of sub max step test, reach 7.7 during 4th stage
$V0_2$	43, VT1=69%, VT2=77%
RECOVERY	8% in 1 min, 18% in 2 min
SPORTS SCIENCE CONSULTATION	Meet with Director of Sports Science
	Introduce Omegawave, how to run assessments, interpert results
TACTICAL	**GENERAL**
PROVIDE WEEKLY TRAINING SCHEDULE	*CURRENT S&C SCHEDULE LISTED BELOW*
	LIST TIME, TYPE OF TRAINING, VOLUME AND INTENSITY
MON: AM - MMA Pro Practice, PM - Wrestling	MON: S&C - Shoulder rehab/strength; Low impact cardio
TUE: AM - Mitts, PM - Big Glove Sparring	TUE:
WED: AM - MMA Pro Practice	WED: S&C - Shoulder rehab/strength; Low impact cardio
THUR: AM - Mitts, PM - MMA Sparring	THUR:
FRI: AM - MMA Pro Practice, PM - Wrestling	FRI: S&C - Shoulder rehab/strength; Low impact cardio
SAT: MMA Grappling/Wrestling	SAT:
SUN: OFF	SUN: OFF
ACCESS TO STRENGTH TRAINING FACILITY?	YES
TRACK?	YES
POOL?	YES
INITIAL PROGRAM DESIGN	TENTATIVE S&C PROGRAM
Phase 1 (4 week block) (3 Days per week)	GPP; 3 progressive weeks + 1 recovery week
	re-evaluate bodyweight/fitness
Phase 2 (4 week block) (3 Days per week)	Progress Glycolytic conditioning; 3 progressive weeks + 1 recovery week
	re-evaluate bodyweight/fitness

Figure 4.7

PRIORITIZING TRAINING

When prioritizing training, there needs to be a flow of decision-making that will realistically set the fighter up for success. There are many factors to consider around camp time, performance goals, weight loss, etc. This decision-making tree for prioritizing the emphasis within the periodization structure should reflect something similar to the process shown in figure 4.8.

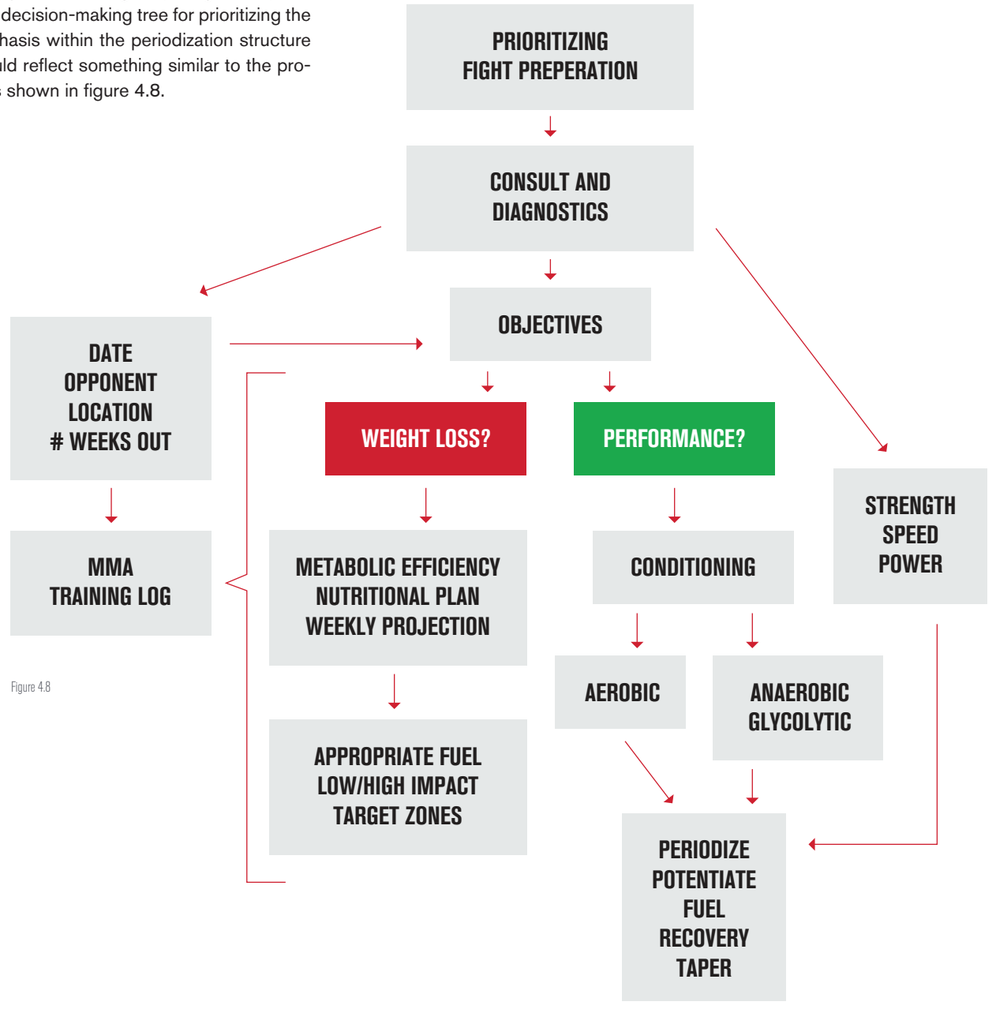


Figure 4.8

QUICK TAKES

Periodization is the process of systematically cycling different training demands to maximize physiological adaptation and increase the probability of 'peaking' for competition.

The physical stress associated with training can be divided into 3 stages:

- Alarm Stage - initial 'shock' to the system
- Resistance Stage - 'Adaptation' to the system
- Exhaustion Stage - inadequate 'repair' to the system

Defining high/moderate/low intensity training days is a simply way to manage fatigue and ensure windows of recovery.

"Off Camp" **sequential linear block periodization** should be implemented:

- Specific intervals of time to develop a singular goal
- Increase in intensity with a concurrent decrease in volume

During "Fight Camp" **daily undulating periodization** is preferred:

- Multiple training stimuli are rotated between workouts during a weekly cycle

Without objective assessment it is difficult to determine the regression or progression of an athlete.

CHAPTER FIVE

PHYSICAL PERFORMANCE BENCHMARKS OF THE UFC ATHLETE

YOU WILL NEVER KNOW YOUR LIMITS UNLESS YOU PUSH YOURSELF TO THEM

UFC fighters are the most physically well-rounded athletes on the planet. The complexities of MMA demand that athletes possess high levels of metabolic conditioning (i.e. sports-specific fitness) concurrently with the capacity to generate explosive knockout strength and power. While the characteristics of individual fighting styles vary, MMA is defined as:

"A high-intensity intermittent sport in which forces must be repeatedly exerted against an external resistance in the form of an opponent."

High force-generating qualities are required to manipulate the mass of an opponent, withstand collisions, and underpin high-velocity techniques such as striking, throws and takedowns. These highly powerful movements are, however, required to be expressed concurrently with levels of conditioning that fulfill the energetic demands of multiple five-minute rounds. The divergent physiology (i.e. power vs. endurance) required by world-class UFC fighters makes MMA the most challenging sport to prepare for.

PHYSICAL CONTEXT

Effort:pause ratios are used as a proxy of 'physiological load' as a way to define the demands of competition. UFC fights have an effort:pause distribution of between 1:3 to 1:4. This can be interpreted as high-intensity epochs of activity that occur for approximately 8-14 seconds interspersed with periods of lower-intensity activity (e.g., clinch work, grappling) lasting 3-4 times as long throughout the duration of a five-minute round. The predominant contributor of energy beyond three minutes of any continuous activity is the aerobic system; meaning MMA fighters need to draw upon aerobic energy metabolism throughout a fight. However, **77% of all UFC bouts are ended during the 8-14-second phases of high-intensity activity,** making the ability to utilize anaerobic energy production to rapidly express explosive strength and power also critical to overall success.

BENCHMARKING

The diverse requirements of UFC competition make understanding the factors which increase the probability of success in the Octagon challenging. The physical requirements of MMA are essential however, as both physical and physiological attributes not only provide the framework upon which technical skills can be executed (i.e. they provide the energy), but they also have the potential to influence whether a fight is won or lost in their own right (e.g. "gassing out").

'Benchmarking' is the process of measuring performance standards against the standards of others considered to be the best (i.e. 'best in class'). By understanding the superior performance standards of others, breaking down what makes such superior performance possible, and then undertaking a gap analysis to compare how you perform, it becomes possible to define opportunities for improvement. Indeed, benchmarking is *the* most strategic and intentional way to yield significant improvement in standards that direct an athlete toward 'world's best' status.

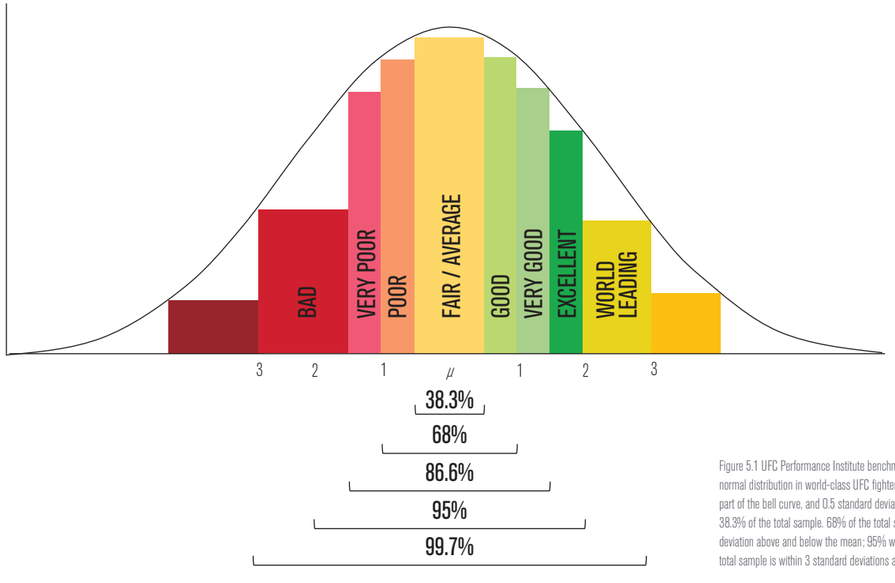


Figure 5.1 UFC Performance Institute benchmarking of physical performance standards using normal distribution in world-class UFC fighters. The group average represents the highest part of the bell curve, and 0.5 standard deviations above and below the mean accounts for 38.3% of the total sample. 68% of the total sample are accounted for within 1 standard deviation above and below the mean; 95% within 2 standard deviations; and 99.7% of the total sample is within 3 standard deviations about the average mean.

STRENGTH QUALITIES

The UFC Performance Institute Strength Quality Assessment Test (SQAT) battery has been implemented to objectively understand the strength and power attributes of UFC fighters (table 5.1). However, not all strength qualities are the same! Instead, MMA requires 'strength' to be expressed in a variety of ways; from very high-velocity/low-force (i.e. speed), to force expressed against an external load at speed (i.e. speed-strength or power), through to maximal force (i.e. max. strength). These physical attributes can be individually evaluated in an effort to address all the respective aspects of the force-velocity relationship that are critical to MMA (figure 5.2).

PHYSICAL ATTRIBUTE	FUNCTIONAL ASSESSMENT	DEPENDENT VARIABLES
REACTIVE STRENGTH	Drop Jump (DJ) from 40cm	RSI $Force_{max}$ (N)
ELASTIC STRENGTH	Counter Movement Jump (CMJ)	Height (cm) Modified RSI $Power_{peak}$ (W) Relative $Force_{max}$ (F/g) Eccentric-Concentric Diff (%) RFD (N/s)
LOWER BODY SPEED-STRENGTH	Loaded Speed Squat (SS) @ 50, 55, and 60% max.	$Velocity_{peak}$ (m/s) $Power_{max}$ (W) Time to $Velocity_{peak}$ (s)
UPPER BODY SPEED-STRENGTH	Loaded Landmine Punch Throw (LPT)	$Velocity_{peak}$ (m/s) $Power_{max}$ (W)
MAXIMAL STRENGTH	Isometric Mid-Thigh Pull (IMTP)	$Force_{max}$ (N) Relative $Force_{max}$ (F/g) Left-Right Diff (%) RFD 100-300ms (N/s) DSD

Table 5.1 UFC PI Strength Quality Assessment Test (SQAT) battery and associated dependent variables. RSI – Reactive Strength Index [DJ flight-time (ms)/DJ contact time (ms)]; N – Newtons; cm – centimeters; F/g – Force times bodyweight; N/s – Newtons per second; m/s – meters per second; s – seconds; W – watts; DSI – Dynamic Strength Index [CMJ F.peak (N)/IMTP F.peak (N)].

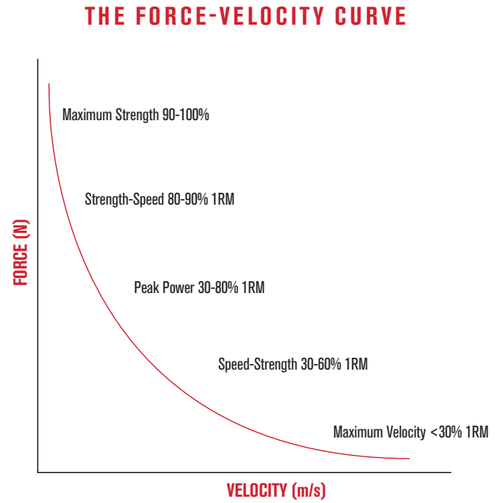


Figure 5.2

REACTIVE STRENGTH

Reactive strength defines the fast stretch-shortening function of muscle. It shows a fighter's ability to rapidly change from an eccentric (breaking) muscle action to a concentric (accelerating) action. Think of throwing explosive combination punches in fast succession or the ability to change direction on the spot in order to open up a new angle for striking. For MMA fighters, reactive strength is critical as it demonstrates the ability to develop the maximal amount of force in fractions of a second against their own bodyweight.

AVERAGE REACTIVE STRENGTH INDEX (RSI) PERFORMANCE STANDARDS BY UFC WEIGHT CLASS

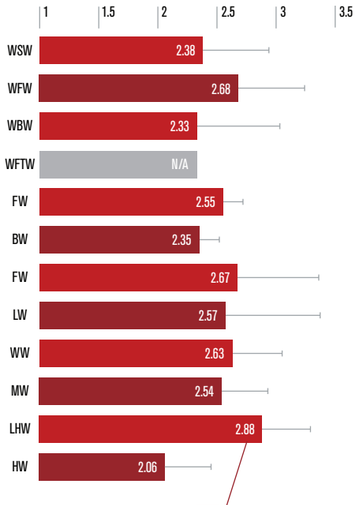


Figure 5.3

2.88
THE HIGHEST AVERAGE RSI PERFORMANCE IS HELD BY LIGHT HEAVYWEIGHT

REACTIVE STRENGTH INDEX (RSI) PERFORMANCE BENCHMARKS BY UFC WEIGHT CLASS

WOMEN'S STRAWWEIGHT (115lb)	
WORLD-LEADING	≤ 3.50
EXCELLENT	3.22 - 3.49
VERY GOOD	2.94 - 3.21
GOOD	2.66 - 2.93
FAIR	2.10 - 2.65
POOR	1.82 - 2.09
VERY POOR	1.54 - 1.81
BAD	≤ 1.53

WOMEN'S FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 3.80
EXCELLENT	3.52 - 3.79
VERY GOOD	2.24 - 3.51
GOOD	2.97 - 3.23
FAIR	2.40 - 2.96
POOR	2.12 - 2.39
VERY POOR	1.84 - 2.11
BAD	≤ 1.83

WOMEN'S BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 3.75
EXCELLENT	3.40 - 3.74
VERY GOOD	3.04 - 3.39
GOOD	2.69 - 3.03
FAIR	1.98 - 2.68
POOR	1.63 - 1.97
VERY POOR	1.27 - 1.62
BAD	≤ 1.26

WOMEN'S FEATHERWEIGHT (145lb)	
WORLD-LEADING	N/A
EXCELLENT	
VERY GOOD	
GOOD	
FAIR	
POOR	
VERY POOR	
BAD	

FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 2.90
EXCELLENT	2.81 - 2.89
VERY GOOD	2.73 - 2.80
GOOD	2.64 - 2.72
FAIR	2.47 - 2.63
POOR	2.38 - 2.46
VERY POOR	2.30 - 2.37
BAD	≤ 2.29

BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 2.69
EXCELLENT	2.61 - 2.68
VERY GOOD	2.52 - 2.60
GOOD	2.44 - 2.51
FAIR	2.26 - 2.43
POOR	2.18 - 2.25
VERY POOR	2.09 - 2.17
BAD	≤ 2.08

FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 4.05
EXCELLENT	3.70 - 4.04
VERY GOOD	3.36 - 3.69
GOOD	3.02 - 3.35
FAIR	2.32 - 3.01
POOR	1.98 - 2.31
VERY POOR	1.64 - 1.97
BAD	≤ 1.63

LIGHTWEIGHT (155lb)	
WORLD-LEADING	≤ 4.19
EXCELLENT	3.79 - 4.18
VERY GOOD	3.39 - 3.78
GOOD	2.98 - 3.38
FAIR	2.17 - 2.97
POOR	1.77 - 2.16
VERY POOR	1.37 - 1.76
BAD	≤ 1.36

WELTERWEIGHT (170lb)	
WORLD-LEADING	≤ 3.49
EXCELLENT	3.27 - 3.48
VERY GOOD	3.06 - 3.26
GOOD	2.85 - 3.05
FAIR	2.42 - 2.84
POOR	2.21 - 2.41
VERY POOR	2.00 - 2.20
BAD	≤ 1.99

MIDDLEWEIGHT (185lb)	
WORLD-LEADING	≤ 3.33
EXCELLENT	3.13 - 3.32
VERY GOOD	2.94 - 3.12
GOOD	2.75 - 2.93
FAIR	2.35 - 2.74
POOR	2.15 - 2.34
VERY POOR	1.96 - 2.14
BAD	≤ 1.95

LIGHT HEAVYWEIGHT (205lb)	
WORLD-LEADING	≤ 3.71
EXCELLENT	3.50 - 3.70
VERY GOOD	2.30 - 3.49
GOOD	3.10 - 3.29
FAIR	2.68 - 3.09
POOR	2.47 - 2.67
VERY POOR	2.27 - 2.46
BAD	≤ 2.26

HEAVYWEIGHT (<265lb)	
WORLD-LEADING	≤ 2.84
EXCELLENT	2.65 - 2.83
VERY GOOD	2.46 - 2.64
GOOD	2.26 - 2.45
FAIR	1.86 - 2.25
POOR	1.67 - 1.85
VERY POOR	1.48 - 1.66
BAD	≤ 1.47

Table 5.2

ELASTIC STRENGTH

Elastic strength refers to the slow, stretch-shortening function of muscle. Elastic strength is also a critical component of athleticism, and it is directly related to the ability to generate peak power (Power = Force x Velocity or in other words Power = Strength x Speed). Elastic strength also uses the stretch-shortening cycle (i.e. eccentric/concentric) of muscle to express power, but in this case the movements tend to be more prolonged in nature (e.g. jumping to throw flying knees, shooting for takedowns).

COUNTER MOVEMENT JUMP HEIGHT (CM) PERFORMANCE BENCHMARKS BY UFC WEIGHT CLASS

WOMEN'S STRAWWEIGHT (115lb)	
WORLD-LEADING	≤ 58.56
EXCELLENT	54.79 - 58.55
VERY GOOD	51.01 - 54.78
GOOD	47.24 - 51.00
FAIR	39.68 - 47.23
POOR	35.91 - 39.67
VERY POOR	32.14 - 35.90
BAD	≤ 32.13

WOMEN'S FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 44.08
EXCELLENT	42.50 - 44.07
VERY GOOD	40.91 - 42.49
GOOD	39.33 - 40.90
FAIR	36.16 - 39.32
POOR	34.58 - 36.15
VERY POOR	32.99 - 34.57
BAD	≤32.98

WOMEN'S BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 40.70
EXCELLENT	40.61 - 40.69
VERY GOOD	40.52 - 40.60
GOOD	40.43 - 40.51
FAIR	40.25 - 40.42
POOR	40.16 - 40.24
VERY POOR	40.07 - 40.15
BAD	≤ 40.06

WOMEN'S FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 62.77
EXCELLENT	59.89 - 62.76
VERY GOOD	57.01 - 59.88
GOOD	54.13 - 57.00
FAIR	48.37 - 54.12
POOR	45.49 - 48.36
VERY POOR	42.61 - 45.48
BAD	≤ 42.60

FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 63.76
EXCELLENT	62.55 - 63.75
VERY GOOD	61.34 - 62.54
GOOD	60.14 - 61.33
FAIR	57.71 - 60.13
POOR	56.51 - 57.70
VERY POOR	55.30 - 56.50
BAD	≤ 55.29

BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 48.61
EXCELLENT	47.37 - 48.60
VERY GOOD	46.13 - 47.36
GOOD	44.89 - 46.12
FAIR	42.40 - 44.88
POOR	41.16 - 42.39
VERY POOR	39.92 - 41.15
BAD	≤ 39.91

FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 60.45
EXCELLENT	58.66 - 60.44
VERY GOOD	56.86 - 58.65
GOOD	55.07 - 56.85
FAIR	51.47 - 55.06
POOR	49.68 - 51.46
VERY POOR	47.89 - 49.67
BAD	≤ 47.88

LIGHTWEIGHT (155lb)	
WORLD-LEADING	≤ 63.39
EXCELLENT	60.97 - 63.38
VERY GOOD	58.56 - 60.96
GOOD	56.14 - 58.55
FAIR	51.30 - 56.13
POOR	48.89 - 51.29
VERY POOR	46.47 - 48.88
BAD	≤ 46.46

WELTERWEIGHT (170lb)	
WORLD-LEADING	≤ 71.89
EXCELLENT	68.06 - 71.88
VERY GOOD	64.23 - 68.05
GOOD	60.41 - 64.22
FAIR	52.74 - 60.40
POOR	48.91 - 52.73
VERY POOR	45.08 - 48.90
BAD	≤ 45.07

MIDDLEWEIGHT (185lb)	
WORLD-LEADING	≤ 66.23
EXCELLENT	63.95 - 66.22
VERY GOOD	61.67 - 63.94
GOOD	59.39 - 61.66
FAIR	54.81 - 59.38
POOR	52.53 - 54.80
VERY POOR	50.25 - 52.52
BAD	≤ 50.24

LIGHT HEAVYWEIGHT (205lb)	
WORLD-LEADING	≤ 73.67
EXCELLENT	70.38 - 73.66
VERY GOOD	67.10 - 70.37
GOOD	63.81 - 67.09
FAIR	57.23 - 63.80
POOR	53.94 - 57.22
VERY POOR	50.65 - 53.93
BAD	≤ 50.64

HEAVYWEIGHT (<265lb)	
WORLD-LEADING	≤ 86.52
EXCELLENT	80.14 - 86.51
VERY GOOD	73.77 - 80.13
GOOD	67.39 - 73.76
FAIR	54.64 - 67.38
POOR	48.26 - 54.63
VERY POOR	41.89 - 48.25
BAD	≤ 41.88

Table 5.3

COUNTER MOVEMENT JUMP PEAK POWER OUTPUT (W) BENCHMARKS BY UFC WEIGHT CLASS

WOMEN'S STRAWWEIGHT (115lb)	
WORLD-LEADING	≤ 3755
EXCELLENT	3574 - 3755
VERY GOOD	3393 - 3574
GOOD	3211 - 3393
FAIR	2849 - 3211
POOR	2667 - 2849
VERY POOR	2486 - 2667
BAD	≤ 2486

WOMEN'S FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 3113
EXCELLENT	3031 - 3113
VERY GOOD	2948 - 3031
GOOD	2866 - 2948
FAIR	2701 - 2866
POOR	2618 - 2701
VERY POOR	2536 - 2618
BAD	≤2536

WOMEN'S BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 4022
EXCELLENT	3839 - 4022
VERY GOOD	3657 - 3839
GOOD	3475 - 3657
FAIR	3111 - 3475
POOR	2929 - 3111
VERY POOR	2746 - 2929
BAD	≤ 2746

WOMEN'S FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 5510
EXCELLENT	5260 - 5510
VERY GOOD	5010 - 5260
GOOD	4760 - 5010
FAIR	4260 - 4760
POOR	4010 - 4260
VERY POOR	3760 - 4010
BAD	≤ 3760

FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 4765
EXCELLENT	4576 - 4765
VERY GOOD	4387 - 4576
GOOD	4199 - 4387
FAIR	3821 - 4199
POOR	3633 - 3821
VERY POOR	3444 - 3633
BAD	≤ 3444

BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 5358
EXCELLENT	5013 - 5358
VERY GOOD	4668 - 5013
GOOD	4323 - 4668
FAIR	3632 - 4323
POOR	3287 - 3632
VERY POOR	2942 - 3287
BAD	≤ 2942

FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 5049
EXCELLENT	4914 - 5049
VERY GOOD	4779 - 4914
GOOD	4643 - 4779
FAIR	4372 - 4643
POOR	4237 - 4372
VERY POOR	4102 - 4237
BAD	≤ 4102

LIGHTWEIGHT (155lb)	
WORLD-LEADING	≤ 5888
EXCELLENT	5635 - 5888
VERY GOOD	5383 - 5635
GOOD	5131 - 5383
FAIR	4626 - 5131
POOR	4373 - 4626
VERY POOR	4121 - 4373
BAD	≤ 4121

WELTERWEIGHT (170lb)	
WORLD-LEADING	≤ 6721
EXCELLENT	6357 - 6721
VERY GOOD	5993 - 6357
GOOD	5630 5993
FAIR	4902 - 5630
POOR	4538 - 4902
VERY POOR	4175 - 4538
BAD	≤ 4175

MIDDLEWEIGHT (185lb)	
WORLD-LEADING	≤ 6689
EXCELLENT	6444 - 6689
VERY GOOD	6199 - 6444
GOOD	5954 - 6199
FAIR	5465 - 5954
POOR	5220 - 5465
VERY POOR	4975 - 5220
BAD	≤ 4975

LIGHT HEAVYWEIGHT (205lb)	
WORLD-LEADING	≤ 8639
EXCELLENT	8241 - 8639
VERY GOOD	7843 - 8241
GOOD	7445 - 7843
FAIR	6649 - 7445
POOR	6251 - 6649
VERY POOR	5854 - 6251
BAD	≤ 5854

HEAVYWEIGHT (<265lb)	
WORLD-LEADING	≤ 9825
EXCELLENT	9204 - 9825
VERY GOOD	8583 - 9204
GOOD	7962 - 8583
FAIR	6720 - 7962
POOR	6099 - 6720
VERY POOR	5477 - 6099
BAD	≤ 5477

Table 5.4

AVERAGE CMJ HEIGHT (CM) PERFORMANCE STANDARDS BY UFC WEIGHT CLASS

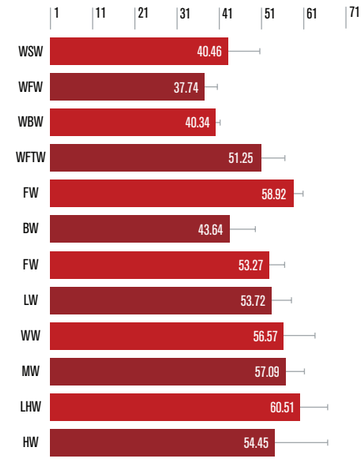


Figure 5.4

AVERAGE CMJ PEAK POWER OUTPUT (W) PERFORMANCE STANDARDS BY UFC WEIGHT CLASS

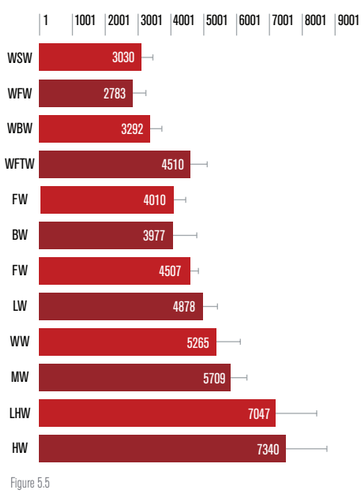


Figure 5.5

SPEED-STRENGTH

Speed-strength requires moving relatively heavy loads as fast as you can. Normally, this load is greater than an individual's own bodyweight (30-60% of maximal capabilities). The speed-strength zone (see figure 5.2) requires fighters to produce maximal force in a shorter time frame than the maximal strength zone, which reduces the amount of force that can be produced but can use higher movement of velocity. This is critical for fighters, as rarely do they have extended periods of time in which to develop lots of force; instead they have fractions of a second to generate as much as possible in the time available (i.e. **Rate of Force Development**). Speed-strength has many applications to MMA, including a fighter's ability manipulate an opponent during takedowns, throws and stand-up clinch work, or explosively defending against takedown attacks.

LOADED SPEED SQUAT PEAK POWER OUTPUT (W) @ 50%1RM BENCHMARKS BY UFC WEIGHT CLASS

WOMEN'S STRAWWEIGHT (115lb)	
WORLD-LEADING	≤ 520
EXCELLENT	490 - 520
VERY GOOD	461 - 490
GOOD	432 - 461
FAIR	373 - 432
POOR	344 - 373
VERY POOR	315 - 344
BAD	≤ 315

WOMEN'S FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 567
EXCELLENT	533 -567
VERY GOOD	499 - 533
GOOD	466 - 499
FAIR	399 - 466
POOR	365 - 399
VERY POOR	331 - 365
BAD	≤ 331

WOMEN'S BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 692
EXCELLENT	641 - 692
VERY GOOD	590 - 641
GOOD	539 - 590
FAIR	436 - 539
POOR	385 - 436
VERY POOR	334 - 385
BAD	≤ 334

WOMEN'S FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 834
EXCELLENT	780 - 834
VERY GOOD	726 - 780
GOOD	671 - 726
FAIR	563 - 671
POOR	508 - 563
VERY POOR	454 - 508
BAD	≤ 454

FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 770
EXCELLENT	719 - 770
VERY GOOD	668 - 719
GOOD	618 - 668
FAIR	516 - 618
POOR	466 -516
VERY POOR	415 - 466
BAD	≤ 415

BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 780
EXCELLENT	741 - 780
VERY GOOD	701 - 741
GOOD	662 - 701
FAIR	583 -662
POOR	543 - 583
VERY POOR	504 - 543
BAD	≤ 504

FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 843
EXCELLENT	810 - 843
VERY GOOD	777 - 810
GOOD	744 - 777
FAIR	678 - 744
POOR	644 - 678
VERY POOR	611 - 644
BAD	≤ 611

LIGHTWEIGHT (155lb)	
WORLD-LEADING	≤ 1012
EXCELLENT	942 - 1012
VERY GOOD	872 - 942
GOOD	803 - 872
FAIR	663 - 803
POOR	593 - 663
VERY POOR	523 - 593
BAD	≤ 523

WELTERWEIGHT (170lb)	
WORLD-LEADING	≤ 1170
EXCELLENT	1065 - 1170
VERY GOOD	959 - 1065
GOOD	853 - 959
FAIR	642 - 853
POOR	536 -642
VERY POOR	430 - 536
BAD	≤ 430

MIDDLEWEIGHT (185lb)	
WORLD-LEADING	≤ 1286
EXCELLENT	1191 - 1286
VERY GOOD	1096 - 1191
GOOD	1001 - 1096
FAIR	812 - 1001
POOR	717 - 812
VERY POOR	622 - 717
BAD	≤ 622

LIGHT HEAVYWEIGHT (205lb)	
WORLD-LEADING	≤ 1469
EXCELLENT	1362 - 1469
VERY GOOD	1255 - 1362
GOOD	1148 - 1255
FAIR	934 - 1148
POOR	827 -934
VERY POOR	720 - 827
BAD	≤ 720

HEAVYWEIGHT (<265lb)	
WORLD-LEADING	≤ 1708
EXCELLENT	1541 - 1708
VERY GOOD	1375 - 1541
GOOD	1208 - 1375
FAIR	876 - 1208
POOR	709 - 876
VERY POOR	543 - 709
BAD	≤ 543

Table 5.5

AVERAGE 50%1RM SPEED SQUAT PEAK POWER OUTPUT (W) PERFORMANCE STANDARDS BY UFC WEIGHT CLASS

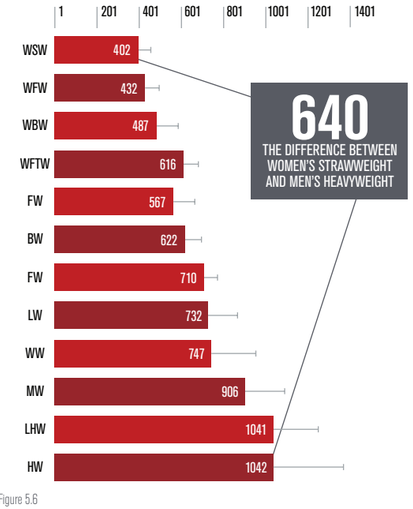


Figure 5.6

MAXIMAL STRENGTH

Maximal strength, or limit strength, is the greatest amount of force that can be produced, regardless of time. All strength qualities are important, but unless you have enough raw horsepower in your engine, you won't be going anywhere or doing anything in a hurry! In this case, you can think of maximum strength and 'horsepower' as being synonymous. Training to increase maximal strength also builds the foundation of 'power' by increasing the force variable in the power equation (P = **F** x V).

ISOMETRIC MID-THIGH PULL PEAK FORCE RELATIVE TO BODYWEIGHT (F*G) BENCHMARKS BY UFC WEIGHT CLASS

WOMEN'S STRAWWEIGHT (115lb)	
WORLD-LEADING	≤ 5.09
EXCELLENT	4.65 - 5.08
VERY GOOD	4.22 - 4.65
GOOD	3.78 - 4.21
FAIR	2.90 - 3.77
POOR	2.47 - 2.89
VERY POOR	2.04 - 2.46
BAD	≤ 2.03

WOMEN'S FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 2.99
EXCELLENT	2.93 - 2.98
VERY GOOD	2.87 - 2.92
GOOD	2.82 - 2.86
FAIR	2.69 - 2.81
POOR	2.64 - 2.68
VERY POOR	2.58 - 2.63
BAD	≤ 2.57

WOMEN'S BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 3.35
EXCELLENT	3.19 - 3.34
VERY GOOD	3.03 - 3.18
GOOD	2.87 - 3.02
FAIR	2.55 - 2.86
POOR	2.39 - 2.54
VERY POOR	2.23 - 2.38
BAD	≤ 2.22

WOMEN'S FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 3.07
EXCELLENT	2.96 - 3.06
VERY GOOD	2.84 - 2.95
GOOD	2.73 - 2.83
FAIR	2.50 - 2.72
POOR	2.39 - 2.49
VERY POOR	2.28 - 2.38
BAD	≤ 2.27

FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 4.63
EXCELLENT	4.38 - 4.62
VERY GOOD	4.13 - 4.37
GOOD	3.88 - 4.12
FAIR	3.38 -3.87
POOR	3.13 - 3.37
VERY POOR	2.88 - 3.12
BAD	≤ 2.87

BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 4.61
EXCELLENT	4.36 - 4.60
VERY GOOD	4.11 - 4.35
GOOD	3.86 -4.10
FAIR	3.35 - 3.85
POOR	3.10 - 3.34
VERY POOR	2.85 - 3.09
BAD	≤ 2.84

FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 4.73
EXCELLENT	4.57 - 4.72
VERY GOOD	4.41 - 4.56
GOOD	4.25 - 4.40
FAIR	3.92 - 4.24
POOR	3.76 - 3.91
VERY POOR	3.60 - 3.75
BAD	≤ 3.59

LIGHTWEIGHT (155lb)	
WORLD-LEADING	≤ 4.33
EXCELLENT	4.10 - 4.32
VERY GOOD	3.87 - 4.09
GOOD	3.65 - 3.86
FAIR	3.18 - 3.64
POOR	2.95 - 3.17
VERY POOR	2.72 - 2.94
BAD	≤ 2.71

WELTERWEIGHT (170lb)	
WORLD-LEADING	≤ 4.57
EXCELLENT	4.32 - 4.56
VERY GOOD	4.08 - 4.31
GOOD	3.84 - 4.07
FAIR	3.35 - 3.83
POOR	3.10 - 3.34
VERY POOR	2.86 - 3.09
BAD	≤ 2.85

MIDDLEWEIGHT (185lb)	
WORLD-LEADING	≤ 4.25
EXCELLENT	4.05 - 4.24
VERY GOOD	3.84 - 4.04
GOOD	3.64 - 3.83
FAIR	3.22 - 3.63
POOR	3.01 - 3.21
VERY POOR	2.81 - 3.00
BAD	≤ 2.80

LIGHT HEAVYWEIGHT (205lb)	
WORLD-LEADING	≤ 4.58
EXCELLENT	4.28 - 4.57
VERY GOOD	3.98 - 4.27
GOOD	3.69 - 3.97
FAIR	3.08 - 3.68
POOR	2.79 - 3.07
VERY POOR	2.49 - 2.78
BAD	≤ 2.48

HEAVYWEIGHT (<265lb)	
WORLD-LEADING	≤ 4.11
EXCELLENT	3.84 - 4.10
VERY GOOD	3.58 - 3.83
GOOD	3.31 - 3.57
FAIR	2.77 - 3.30
POOR	2.51 - 2.76
VERY POOR	2.24 - 2.50
BAD	≤ 2.23

Table 5.6

AVERAGE IMTP RELATIVE STRENGTH (F*G) PERFORMANCE STANDARDS BY UFC WEIGHT CLASS

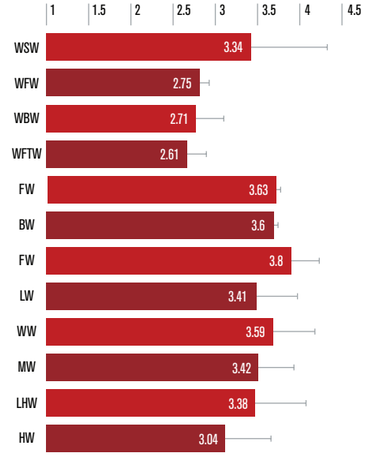


Figure 5.7

ISOMETRIC MID-THIGH PULL PEAK FORCE (N) BENCHMARKS BY UFC WEIGHT CLASS

WOMEN'S STRAWWEIGHT (115lb)	
WORLD-LEADING	≤ 3157
EXCELLENT	2872 - 3157
VERY GOOD	2586 - 2872
GOOD	2300 - 2586
FAIR	1728 - 2300
POOR	1442 - 1728
VERY POOR	1156 - 1442
BAD	≤ 1156

WOMEN'S FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 2038
EXCELLENT	1995 - 2038
VERY GOOD	1951 - 1995
GOOD	1908 - 1951
FAIR	1820 -1908
POOR	1777 - 1820
VERY POOR	1733 - 1777
BAD	≤ 1733

WOMEN'S BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 2391
EXCELLENT	2268 - 2391
VERY GOOD	2146 - 2268
GOOD	2023 - 2146
FAIR	1777 - 2023
POOR	1655 - 1777
VERY POOR	1532 -1655
BAD	≤ 1532

WOMEN'S FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 2233
EXCELLENT	2162 - 2233
VERY GOOD	2091 -2162
GOOD	2021 -2091
FAIR	1879 - 2021
POOR	1809 - 1879
VERY POOR	1738 - 1809
BAD	≤ 1738

FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 3150
EXCELLENT	2933 - 3150
VERY GOOD	2715 -2933
GOOD	2498 - 2715
FAIR	2062 - 2498
POOR	1845 -2062
VERY POOR	1627 -1845
BAD	≤ 1627

BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 3294.53
EXCELLENT	3121.73 - 3294.52
VERY GOOD	2948.93 - 3121.72
GOOD	2776.14 - 2948.92
FAIR	2430.54 - 2776.13
POOR	2257.74 - 2430.53
VERY POOR	2084.95 - 2257.73
BAD	≤ 2084.94

FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 3531.85
EXCELLENT	3418.89 - 3531.84
VERY GOOD	3305.93 - 3418.88
GOOD	3192.97 - 3305.92
FAIR	2967.04 - 3192.96
POOR	2854.08 - 2967.03
VERY POOR	2741.12 - 2854.07
BAD	≤ 2741.11

LIGHTWEIGHT (155lb)	
WORLD-LEADING	≤ 3595.02
EXCELLENT	3404.77 - 3595.01
VERY GOOD	3214.51 - 3404.76
GOOD	3024.26 - 3214.50
FAIR	2643.75 - 3024.25
POOR	2453.50 - 2643.74
VERY POOR	2263.24 - 2453.49
BAD	≤ 2263.23

WELTERWEIGHT (170lb)	
WORLD-LEADING	≤ 3882
EXCELLENT	3678 - 3882
VERY GOOD	3474 - 3678
GOOD	3270 - 3474
FAIR	2862 - 3270
POOR	2659 - 2862
VERY POOR	2455 - 2659
BAD	≤ 2455

MIDDLEWEIGHT (185lb)	
WORLD-LEADING	≤ 3932
EXCELLENT	3748 - 3932
VERY GOOD	3564 - 3748
GOOD	3381 - 3564
FAIR	3013 - 3381
POOR	2830 - 3013
VERY POOR	2646 - 2830
BAD	≤ 2646

LIGHT HEAVYWEIGHT (205lb)	
WORLD-LEADING	≤ 4426
EXCELLENT	4143 - 4426
VERY GOOD	3860 - 4143
GOOD	3577 - 3860
FAIR	3011 - 3577
POOR	2729 - 3011
VERY POOR	2446 - 2729
BAD	≤ 2446

HEAVYWEIGHT (<265lb)	
WORLD-LEADING	≤ 4925
EXCELLENT	4573 - 4925
VERY GOOD	4221 - 4573
GOOD	3870 - 4221
FAIR	3166 - 3870
POOR	2814 - 3166
VERY POOR	2462 - 2814
BAD	≤ 2462

Table 5.7

AVERAGE IMTP PEAK FORCE (N) PERFORMANCE STANDARDS BY UFC WEIGHT CLASS

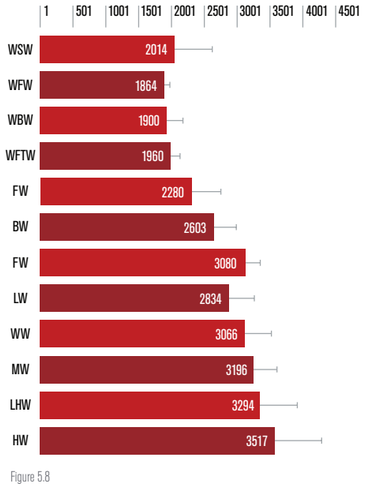


Figure 5.8

ISOMETRIC MID-THIGH PULL RATE OF FORCE DEVELOPMENT 100-300MS (N/S) BENCHMARKS BY UFC WEIGHT CLASS

WOMEN'S STRAWWEIGHT (115lb)	
WORLD-LEADING	≤ 5493
EXCELLENT	5123 - 5493
VERY GOOD	4752 - 5123
GOOD	4382 - 4752
FAIR	3642 - 4382
POOR	3272 - 3642
VERY POOR	2901 - 3272
BAD	≤ 2901

WOMEN'S FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 5267
EXCELLENT	5156 - 5267
VERY GOOD	5046 - 5156
GOOD	4935 - 5046
FAIR	4713 - 4935
POOR	4602 - 4713
VERY POOR	4492 - 4602
BAD	≤ 4492

WOMEN'S BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 6064
EXCELLENT	5603 - 6064
VERY GOOD	5142 - 5603
GOOD	4681 - 5142
FAIR	3759 - 4681
POOR	3298 - 3759
VERY POOR	2837 - 3298
BAD	≤ 2837

WOMEN'S FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 7212
EXCELLENT	6519 - 7212
VERY GOOD	5826 - 6519
GOOD	5133 - 5826
FAIR	3747 - 5133
POOR	3054 - 3747
VERY POOR	2361 - 3054
BAD	≤ 2361

FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 4927
EXCELLENT	4800 - 4927
VERY GOOD	4674 - 4800
GOOD	4547 - 4674
FAIR	4293 - 4547
POOR	4166 - 4293
VERY POOR	4040 - 4166
BAD	≤ 4040

BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 5442.47
EXCELLENT	5268.52 - 5442.46
VERY GOOD	5094.58 - 5268.51
GOOD	4920.63 - 5094.57
FAIR	4572.72 - 4920.62
POOR	4398.77 - 4572.71
VERY POOR	4224.82 - 4398.76
BAD	≤ 4224.81

FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 7789.23
EXCELLENT	7429.43 - 7789.22
VERY GOOD	7069.62 - 7429.42
GOOD	6709.82 - 7069.61
FAIR	5990.19 - 6709.81
POOR	5630.39 - 5990.18
VERY POOR	5270.58 - 5630.38
BAD	≤ 5270.57

LIGHTWEIGHT (155lb)	
WORLD-LEADING	≤ 8281.03
EXCELLENT	7736.27 - 8281.02
VERY GOOD	7191.52 - 7736.26
GOOD	6646.76 - 7191.51
FAIR	5557.25 - 6646.75
POOR	5012.49 - 5557.24
VERY POOR	4467.74 - 5012.48
BAD	≤ 4467.73

WELTERWEIGHT (170lb)	
WORLD-LEADING	≤ 8920
EXCELLENT	8158 - 8920
VERY GOOD	7395 - 8158
GOOD	6633 - 7395
FAIR	5107 - 6633
POOR	4345 - 5107
VERY POOR	3582 - 4345
BAD	≤ 3582

MIDDLEWEIGHT (185lb)	
WORLD-LEADING	≤ 8390
EXCELLENT	7997 - 8390
VERY GOOD	7604 - 7997
GOOD	7210 - 7604
FAIR	6424 - 7210
POOR	6030 - 6424
VERY POOR	5637 - 6030
BAD	≤ 5637

LIGHT HEAVYWEIGHT (205lb)	
WORLD-LEADING	≤ 12103
EXCELLENT	10778 - 12103
VERY GOOD	9453 - 10778
GOOD	8128 - 9453
FAIR	5478 - 8128
POOR	4154 - 5478
VERY POOR	2828 - 4153
BAD	≤ 2828

HEAVYWEIGHT (<265lb)	
WORLD-LEADING	≤ 12228
EXCELLENT	10739 - 12228
VERY GOOD	9249 - 10739
GOOD	7760 - 9249
FAIR	4780 - 7760
POOR	3291 - 4780
VERY POOR	1801 - 3291
BAD	≤ 1801

Table 5.8

AVERAGE IMTP RATE OF FORCE DEVELOPMENT 100-300MS (N/S) PERFORMANCE STANDARDS BY UFC WEIGHT CLASS

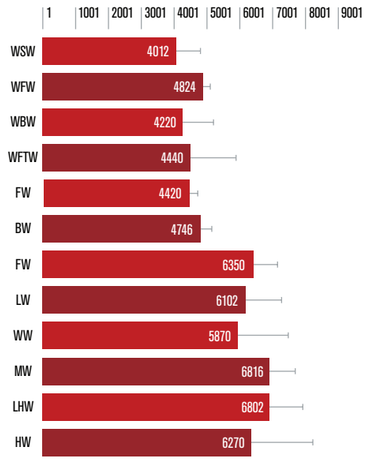


Figure 5.9

DYNAMIC STRENGTH DEFICIT

The Dynamic Strength Deficit (DSD) is the ratio between peak force produced during ballistic movements (i.e. CMJ) and the peak force produced during static movements (IMTP). DSD is one of the most underrated metrics in athletic performance, as it provides coaches with an understanding of the strength qualities that are *lacking* in an athlete. A DSD of ≤0.60 has been shown to relate to athletes who require more ballistic-type training in their program, whereas a ratio of ≥0.81 indicates that maximal strength training is most likely to have the biggest influence on increasing performance.

AVERAGE DYNAMIC STRENGTH DEFICIT ([CMJ F.PEAK/IMTP F.PEAK]) PERFORMANCE STANDARDS BY UFC WEIGHT CLASS

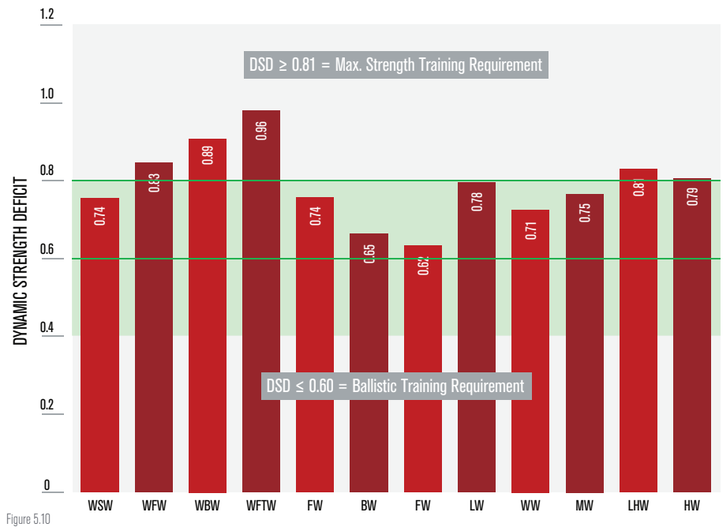


Figure 5.10

ENERGY SYSTEM QUALITIES

Metabolic conditioning represents the extent to which the systems of the body are able to create the energy needed for sports performance. Energy systems directly influence the standards and quality of MMA performance (see table 5.9). Importantly, the energy systems of your body, be they anaerobic (i.e. without oxygen) or aerobic (i.e. with oxygen), don't know the difference between a swimming workout, running, MMA practice, riding an assault bike, jumping on a cross-trainer, or repping-out a bodyweight circuit. All the body recognizes is the **'energy cost of exercise'** for each of those modalities. All the body responds to is 'how fast does it need to deliver energy in order to fulfill the requirements of intensity and duration?' That's the only language it understands—the currency of *energy*. So, when considering energy-system training for MMA, it isn't about the specific exercises you choose; kettlebell vs. bodyweight, tire flips vs. free weights, or battle ropes vs. treadmill. Instead, what is important is the methodology and framework that exercises are inserted into (i.e. how they manipulate the characteristics of 'energy cost' to induce beneficial adaptations).

ANAEROBIC ALACTIC ENERGY SYSTEM - Used for very high intensity, 95-100% of maximum effort. It only lasts for about 10 seconds but recovers very quickly; 50% in 30 seconds and 100% in 2 minutes. It does not require oxygen.

ANAEROBIC LACTIC ENERGY SYSTEM - Also used for high intensity but from 60 to 95% of maximum effort. If working at 95% it will provide energy for about 30 seconds, and at 60% it will last about 30 mins. A byproduct of this energy system is lactate (i.e. 'lactic acid'), which is associated with muscular fatigue. Like the alactic system it does not require oxygen.

AEROBIC ENERGY SYSTEM - Used for low intensity work up to 60% of maximum effort. At low intensity there is no limit to how long you can go. This system however does require oxygen.

Table 5.9

BIOENERGETIC THRESHOLDS

"Threshold: a level, point or value above which something will take place and below which it will not."

Understanding how the body transitions from aerobic to anaerobic energy utilization, or vice versa, gives great insight as to the effectiveness of the body to deliver and utilize energy. For example, during submaximal exercise, the ability to utilize aerobic energy production at high relative intensities (i.e. percentage of max) is a great indicator of metabolic 'efficiency,' as it ultimately shows that a fighter has the ability to delay the onset of fatigue, which is critical to MMA.

Ventilatory Thresholds are an effective way to understand critical aspects of the physical fitness of a fighter. While not technically the same, research has shown that ventilatory thresholds (i.e. changes in breathing characteristics) and lactate thresholds (sometimes referred to as anaerobic thresholds) are reached at roughly similar exercise intensities and can therefore be used to indicate the same thing. These thresholds reflect specific changes from aerobic to anaerobic energy production and mark specific points where oxygen delivery to the muscles becomes a limiting factor forcing the body to rely more on its anaerobic energy systems to support the equivalent workout intensity (see figure 5.11). Metabolically, the thresholds are associated with a rise in lactate and therefore are a very good way to interpret how the body responds to the demands of an exercise stimulus.

- **Ventilatory Threshold 1 (VT1)** - The exercise intensity at which ventilation increases disproportionately to increases in workload, and the point where **lactate begins to accumulate in the blood.** This is an important threshold for MMA fighters, as it identifies the 'efficiency' of a fighter to use aerobic energy at lower intensity for sustained periods, thus preventing the onset of highly fatiguing anaerobic energy production. **The higher this threshold the better,** both in terms of the amount of oxygen being consumed (see table 5.10) and the percent of maximum at which it occurs (see table 5.11).

- **Ventilatory Threshold 2 (VT2)** - An elevated marker of intensity and the point at which **lactate production overtakes lactate removal.** This is perhaps the most critical threshold for MMA fighters, as it represents their ability to work at very high intensities while delaying the onset of fatigue due to lactate accumulations and metabolic acidosis (i.e. the continuous "grind" throughout a round). This threshold is also termed the 'anaerobic threshold,' as it is the point above which fatigue will be certain if the associated work rate (i.e. intensity) is sustained. Once again, we want this threshold to be **as high (i.e. delayed) as possible** (see table 5.12) and to occur at the highest percentage of VO_2max (see table 5.13).

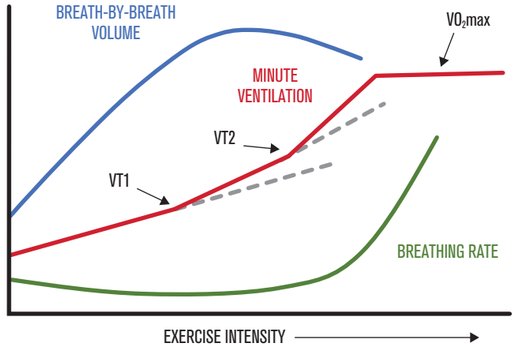


Figure 5.11 Schematic representation of ventilatory thresholds during incremental exercise. VT1 = first ventilatory threshold; VT2 = second ventilatory threshold; VO_2max = maximal aerobic capacity.

AVERAGE VO_2 EQUIVALENT (mlO_2/KG/MIN) FOR VT1 PERFORMANCE STANDARDS BY UFC WEIGHT CLASS

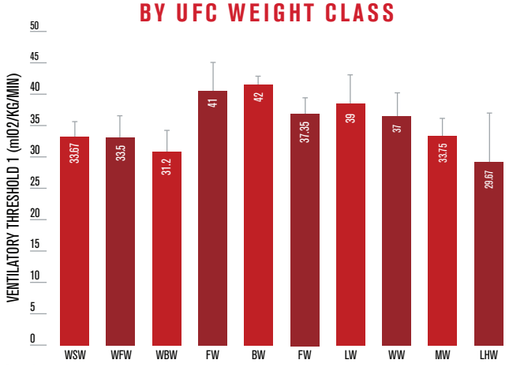


Figure 5.12

AVERAGE VO_2 EQUIVALENT (mlO_2/KG/MIN) FOR VT2 PERFORMANCE STANDARDS BY UFC WEIGHT CLASS

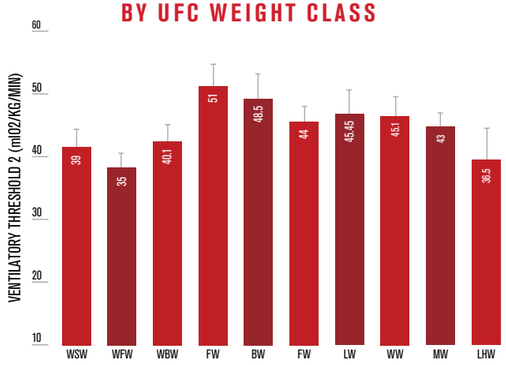


Figure 5.13

VENTILATORY THRESHOLD 1 (VT1)(mlO_2/KG/MIN) BENCHMARKS BY UFC WEIGHT CLASS

WOMEN'S STRAWWEIGHT (115lb)	
WORLD-LEADING	≤ 39
EXCELLENT	37 - 39
VERY GOOD	36 - 37
GOOD	35 - 36
FAIR	32 - 35
POOR	31 - 32
VERY POOR	30 - 31
BAD	≤ 30

WOMEN'S FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 41
EXCELLENT	39 - 41
VERY GOOD	37 - 39
GOOD	35 - 37
FAIR	32 - 35
POOR	30 - 32
VERY POOR	28 - 30
BAD	≤ 28

WOMEN'S BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 38
EXCELLENT	36 - 38
VERY GOOD	35 - 36
GOOD	33 - 35
FAIR	29 - 33
POOR	28 - 29
VERY POOR	26 - 28
BAD	≤ 26

FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 50
EXCELLENT	48 - 50
VERY GOOD	46 - 48
GOOD	43 - 46
FAIR	39 - 43
POOR	36 - 39
VERY POOR	34 - 36
BAD	≤ 34

BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 44.83
EXCELLENT	44.13 - 44.82
VERY GOOD	43.42 - 44.12
GOOD	42.72 - 43.41
FAIR	41.30 - 42.71
POOR	40.59 - 41.29
VERY POOR	39.89 - 40.58
BAD	≤ 39.88

FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 42.50
EXCELLENT	41.22 - 42.49
VERY GOOD	39.93 - 41.21
GOOD	38.65 - 39.92
FAIR	36.07 - 38.64
POOR	34.78 - 36.06
VERY POOR	33.50 - 34.77
BAD	≤ 33.49

LIGHTWEIGHT (155lb)	
WORLD-LEADING	≤ 48.27
EXCELLENT	45.96 - 48.26
VERY GOOD	43.64 - 45.95
GOOD	41.33 - 43.63
FAIR	36.69 - 41.32
POOR	34.37 - 36.68
VERY POOR	32.06 - 34.36
BAD	≤ 32.05

WELTERWEIGHT (170lb)	
WORLD-LEADING	≤ 44
EXCELLENT	43 - 44
VERY GOOD	41 - 43
GOOD	39 - 41
FAIR	35 - 39
POOR	33 - 35
VERY POOR	31 - 33
BAD	≤ 31

MIDDLEWEIGHT (185lb)	
WORLD-LEADING	≤ 40
EXCELLENT	38 - 39
VERY GOOD	37 - 38
GOOD	35 - 37
FAIR	32 - 35
POOR	31 - 32
VERY POOR	29 - 31
BAD	≤ 29

LIGHT HEAVYWEIGHT (205lb)	
WORLD-LEADING	≤ 45
EXCELLENT	41 - 45
VERY GOOD	37 - 41
GOOD	34 - 37
FAIR	26 - 34
POOR	22 - 26
VERY POOR	18 - 22
BAD	≤ 18

Table 5.10

VENTILATORY THRESHOLD 1 (VT1) AS A % OF VO_2MAX. BENCHMARKS BY UFC WEIGHT CLASS

WOMEN'S STRAWWEIGHT (115lb)	
WORLD-LEADING	≤ 78.6
EXCELLENT	76.9 - 78.6
VERY GOOD	75.2 - 76.9
GOOD	73.5 - 75.2
FAIR	70.1 - 73.5
POOR	68.4 - 70.1
VERY POOR	66.7 - 68.4
BAD	≤ 66.7

WOMEN'S FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 79.7
EXCELLENT	78.2 - 79.7
VERY GOOD	76.6 - 78.2
GOOD	75.1 - 76.6
FAIR	72.0 - 75.1
POOR	70.4 - 71.9
VERY POOR	68.9 - 70.4
BAD	≤ 68.8

WOMEN'S BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 76.6
EXCELLENT	74.0 - 76.6
VERY GOOD	71.4 - 74.0
GOOD	68.8 - 71.4
FAIR	63.6 - 68.8
POOR	61.0 - 63.6
VERY POOR	58.4 - 61.0
BAD	≤ 58.4

FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 81.8
EXCELLENT	80.1 - 81.8
VERY GOOD	78.3 - 80.1
GOOD	76.6 - 78.3
FAIR	73.1 - 76.6
POOR	71.3 - 73.0
VERY POOR	69.6 - 71.3
BAD	≤ 69.5

BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 81.91
EXCELLENT	80.06 - 81.90
VERY GOOD	78.21 - 80.05
GOOD	76.36 - 78.20
FAIR	72.65 - 76.35
POOR	70.80 - 72.64
VERY POOR	68.95 - 70.79
BAD	≤ 68.94

FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 78.61
EXCELLENT	76.21 - 78.60
VERY GOOD	73.81 - 76.20
GOOD	71.41 - 73.80
FAIR	66.60 - 71.40
POOR	64.20 - 66.59
VERY POOR	61.80 - 64.19
BAD	≤ 61.79

LIGHTWEIGHT (155lb)	
WORLD-LEADING	≤ 81.11
EXCELLENT	78.61 - 81.10
VERY GOOD	76.11 - 78.60
GOOD	73.61 - 76.10
FAIR	68.60 - 73.60
POOR	66.10 - 68.59
VERY POOR	63.60 - 66.09
BAD	≤ 63.59

WELTERWEIGHT (170lb)	
WORLD-LEADING	≤ 81.9
EXCELLENT	78.5 - 81.9
VERY GOOD	75.0 - 78.5
GOOD	71.6 - 75.0
FAIR	64.7 - 71.6
POOR	61.2 - 64.6
VERY POOR	57.8 - 61.2
BAD	≤ 57.7

MIDDLEWEIGHT (185lb)	
WORLD-LEADING	≤ 79.5
EXCELLENT	76.1 - 79.5
VERY GOOD	72.6 - 76.1
GOOD	69.2 - 72.6
FAIR	62.3 - 69.2
POOR	58.8 - 62.2
VERY POOR	55.4 - 58.8
BAD	≤ 55.3

LIGHT HEAVYWEIGHT (205lb)	
WORLD-LEADING	≤ 76.0
EXCELLENT	72.8 - 76.0
VERY GOOD	69.5 - 72.8
GOOD	66.3 - 69.5
FAIR	59.8 - 66.3
POOR	56.5 - 59.7
VERY POOR	53.3 - 56.5
BAD	≤ 53.2

Table 5.11

VENTILATORY THRESHOLD 2 (VT2) (mlO_2/KG/MIN) BENCHMARKS BY UFC WEIGHT CLASS

WOMEN'S STRAWWEIGHT (115lb)	
WORLD-LEADING	≤ 46.0
EXCELLENT	44.3 - 46.0
VERY GOOD	42.5 - 44.3
GOOD	40.8 - 42.5
FAIR	37.3 - 40.8
POOR	35.5 - 37.2
VERY POOR	33.8 - 35.5
BAD	≤ 33.7

WOMEN'S FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 40.6
EXCELLENT	39.2 - 40.6
VERY GOOD	37.8 - 39.2
GOOD	36.4 - 37.8
FAIR	33.6 - 36.4
POOR	32.2 - 33.6
VERY POOR	30.8 - 32.2
BAD	≤ 30.8

WOMEN'S BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 46.7
EXCELLENT	45.1 - 46.7
VERY GOOD	43.4 - 45.1
GOOD	41.8 - 43.4
FAIR	38.5 - 41.8
POOR	36.8 - 38.4
VERY POOR	35.2 - 36.8
BAD	≤ 35.1

FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 59.6
EXCELLENT	57.5 - 59.6
VERY GOOD	55.3 - 57.5
GOOD	53.2 - 55.3
FAIR	48.9 - 53.2
POOR	46.7 - 48.8
VERY POOR	44.6 - 46.7
BAD	≤ 44.5

BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 58.31
EXCELLENT	55.86 - 58.30
VERY GOOD	53.41 - 55.85
GOOD	50.96 - 53.40
FAIR	46.05 - 50.95
POOR	43.60 - 46.04
VERY POOR	41.15 - 43.59
BAD	≤ 41.14

FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 50.01
EXCELLENT	48.51 - 50.00
VERY GOOD	47.01 - 48.50
GOOD	45.51 - 47.00
FAIR	42.50 - 45.50
POOR	41.00 - 42.49
VERY POOR	39.50 - 40.99
BAD	≤ 39.49

LIGHTWEIGHT (155lb)	
WORLD-LEADING	≤ 55.06
EXCELLENT	52.66 - 55.05
VERY GOOD	50.26 - 52.65
GOOD	47.86 - 50.25
FAIR	43.05 - 47.85
POOR	40.65 - 43.04
VERY POOR	38.25 - 40.64
BAD	≤ 38.24

WELTERWEIGHT (170lb)	
WORLD-LEADING	≤ 52.7
EXCELLENT	50.8 - 52.7
VERY GOOD	48.9 - 50.8
GOOD	47.0 - 48.9
FAIR	43.2 - 47.0
POOR	41.3 - 43.2
VERY POOR	39.4 - 41.3
BAD	≤ 39.4

MIDDLEWEIGHT (185lb)	
WORLD-LEADING	≤ 48.4
EXCELLENT	47.1 - 48.4
VERY GOOD	45.7 - 47.1
GOOD	44.4 - 45.7
FAIR	41.6 - 44.4
POOR	40.3 - 41.6
VERY POOR	38.9 - 40.3
BAD	≤ 38.9

LIGHT HEAVYWEIGHT (205lb)	
WORLD-LEADING	≤ 49.0
EXCELLENT	45.9 - 49.0
VERY GOOD	42.8 - 45.9
GOOD	39.6 - 42.8
FAIR	33.4 - 39.6
POOR	30.3 - 33.4
VERY POOR	27.1 - 30.2
BAD	≤ 27.1

Table 5.12

VENTILATORY THRESHOLD 2 (VT2) AS A % OF VO_2MAX. BENCHMARKS BY UFC WEIGHT CLASS

WOMEN'S STRAWWEIGHT (115lb)	
WORLD-LEADING	≤ 97.8
EXCELLENT	94.4 - 97.8
VERY GOOD	90.9 - 94.4
GOOD	87.5 - 90.9
FAIR	80.6 - 87.5
POOR	77.1 - 80.5
VERY POOR	73.7 - 77.1
BAD	≤ 73.6

WOMEN'S FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 79.8
EXCELLENT	79.1 - 79.8
VERY GOOD	78.4 - 79.1
GOOD	77.7 - 78.4
FAIR	76.3 - 77.7
POOR	75.6 -76.3
VERY POOR	74.9 - 75.6
BAD	≤ 74.9

WOMEN'S BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 92.2
EXCELLENT	89.9 - 92.2
VERY GOOD	87.6 - 89.9
GOOD	85.3 - 87.6
FAIR	80.7 - 85.3
POOR	78.4 - 80.7
VERY POOR	76.1 - 78.4
BAD	≤ 76.1

FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 91.0
EXCELLENT	89.0 - 91.0
VERY GOOD	87.0 - 89.0
GOOD	85.0 - 87.0
FAIR	81.0 - 85.0
POOR	79.0 - 81.0
VERY POOR	77.0 - 79.0
BAD	≤ 77.0

BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 88.21
EXCELLENT	87.16 - 88.20
VERY GOOD	86.11 - 87.15
GOOD	85.06 - 86.10
FAIR	82.95 - 85.05
POOR	81.90 - 82.94
VERY POOR	80.85 - 81.89
BAD	≤ 80.84

FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 88.81
EXCELLENT	86.86 - 88.80
VERY GOOD	84.91 - 86.85
GOOD	82.96 - 84.90
FAIR	79.05 - 82.95
POOR	77.10 - 79.04
VERY POOR	75.15 - 77.09
BAD	≤ 75.14

LIGHTWEIGHT (155lb)	
WORLD-LEADING	≤ 89.01
EXCELLENT	87.26 -89.00
VERY GOOD	85.51 - 87.25
GOOD	83.76 - 85.50
FAIR	80.25 - 83.75
POOR	78.50 - 80.24
VERY POOR	76.75 - 78.49
BAD	≤ 76.74

WELTERWEIGHT (170lb)	
WORLD-LEADING	≤ 90.2
EXCELLENT	88.4 - 90.2
VERY GOOD	86.6 - 88.4
GOOD	84.8 - 86.6
FAIR	81.2 - 84.8
POOR	79.4 - 81.2
VERY POOR	77.6 - 79.4
BAD	≤ 77.6

MIDDLEWEIGHT (185lb)	
WORLD-LEADING	≤ 90.4
EXCELLENT	88.6 - 90.4
VERY GOOD	86.7 - 88.6
GOOD	84.9 - 86.7
FAIR	81.2 - 84.9
POOR	79.3 - 81.1
VERY POOR	77.5 - 79.3
BAD	≤ 77.4

LIGHT HEAVYWEIGHT (205lb)	
WORLD-LEADING	≤ 85.6
EXCELLENT	84.0 - 85.6
VERY GOOD	82.3 - 84.0
GOOD	80.7 - 82.3
FAIR	77.4 - 80.7
POOR	75.7 - 77.3
VERY POOR	74.1 - 75.7
BAD	≤ 74.0

Table 5.13

VT1 AND VT2 THRESHOLDS AS A % OF VO_2MAX BY UFC WEIGHT CLASS.

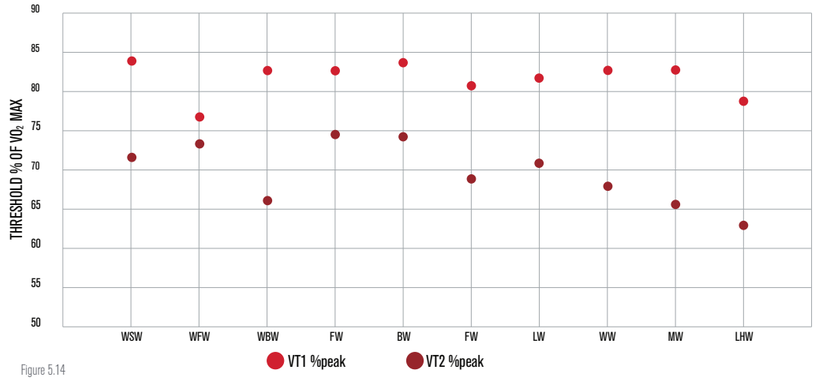


Figure 5.14

MAXIMAL AEROBIC CAPACITY

In simple terms, VO_2max (or VO_2peak) is the maximum amount of oxygen that your system is capable of delivering to your working muscles to support energy production. This rate of maximal oxygen consumption reflects the aerobic conditioning of a fighter and is an important determinant of endurance 'capacity' during sustained work, as well as playing a significant role in supporting the recovery of anaerobic energy stores. Indeed, often overlooked is that the aerobic energy system is responsible for re-synthesizing ATP (i.e. energy) after periods of high-intensity effort, and therefore it influences how fighters recover between rounds and between explosive fighting exchanges. Simply put, if more oxygen is delivered to the working muscles, their endurance will improve, as they will rely less on anaerobic processes for energy.

It is important to understand that VO_2max should never be considered on its own as a holistic measure of a fighter's conditioning. Instead it should always be considered alongside the anaerobic and lactate thresholds in MMA fighters, as the thresholds often provide more valuable information than the max itself. Owing to the varying energetic demands of MMA, it is crucial that consideration is always given to a fighter's bioenergetics relating to anaerobic power, anaerobic capacity (i.e. lactate tolerance), and maximal aerobic capabilities.

VO_2MAX. (mlO_2/KG/MIN) BENCHMARKS BY UFC WEIGHT CLASS

WOMEN'S STRAWWEIGHT (115lb)	
WORLD-LEADING	≤ 59.7
EXCELLENT	57.3 - 59.7
VERY GOOD	54.8 - 57.3
GOOD	52.4 - 54.8
FAIR	47.5 - 52.4
POOR	45.0 - 47.4
VERY POOR	42.6 - 45.0
BAD	≤ 42.5

WOMEN'S FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 52.5
EXCELLENT	51.5 - 52.5
VERY GOOD	50.4 - 51.5
GOOD	49.4 - 50.4
FAIR	47.3 - 49.4
POOR	46.2 - 47.2
VERY POOR	45.2 - 46.2
BAD	≤ 45.1

WOMEN'S BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 66.2
EXCELLENT	63.0 - 66.2
VERY GOOD	59.7 - 63.0
GOOD	56.5 - 59.7
FAIR	50.0 - 56.5
POOR	46.7 - 49.9
VERY POOR	43.5 - 46.7
BAD	≤ 43.4

FLYWEIGHT (125lb)	
WORLD-LEADING	≤ 71.7
EXCELLENT	69. - 71.7
VERY GOOD	67.6 - 69.7
GOOD	65.6 - 67.6
FAIR	61.5 - 65.6
POOR	59.4 - 61.4
VERY POOR	57.4 - 59.4
BAD	≤ 57.3

BANTAMWEIGHT (135lb)	
WORLD-LEADING	≤ 62.01
EXCELLENT	61.31 - 62.00
VERY GOOD	60.61 - 61.30
GOOD	59.91 - 60.60
FAIR	58.50 - 59.90
POOR	57.80 - 58.49
VERY POOR	57.10 - 57.79
BAD	≤ 57.09

FEATHERWEIGHT (145lb)	
WORLD-LEADING	≤ 64.21
EXCELLENT	62.71 - 64.20
VERY GOOD	61.21 - 62.70
GOOD	59.71 - 61.20
FAIR	56.70 - 59.70
POOR	55.20 - 56.69
VERY POOR	53.70 - 55.19
BAD	≤ 53.69

LIGHTWEIGHT (155lb)	
WORLD-LEADING	≤ 70.11
EXCELLENT	67.21 - 70.10
VERY GOOD	64.31 - 67.20
GOOD	61.41 - 64.30
FAIR	55.60 - 61.40
POOR	52.70 - 55.59
VERY POOR	49.80 - 52.69
BAD	≤ 49.79

WELTERWEIGHT (170lb)	
WORLD-LEADING	≤ 67.2
EXCELLENT	64.6 - 67.2
VERY GOOD	62.0 - 64.6
GOOD	59.4 - 62.0
FAIR	54.2 - 59.4
POOR	51.6 - 54.2
VERY POOR	49.0 - 51.6
BAD	≤ 49.0

MIDDLEWEIGHT (185lb)	
WORLD-LEADING	≤ 59.3
EXCELLENT	58.1 - 59.3
VERY GOOD	56.8 - 58.1
GOOD	55.6 - 56.8
FAIR	53.1 - 55.6
POOR	51.8 - 53.0
VERY POOR	50.6 - 51.8
BAD	≤ 50.5

LIGHT HEAVYWEIGHT (205lb)	
WORLD-LEADING	≤ 63.3
EXCELLENT	59.8 - 63.3
VERY GOOD	56.2 - 59.8
GOOD	52.7 - 56.2
FAIR	45.6 - 52.7
POOR	42.0 - 45.5
VERY POOR	38.5 - 42.0
BAD	≤ 38.4

Table 5.14

RECOVERABILITY

Contested over five-minute rounds with a one-minute break between rounds, the work:rest ratio of MMA places athletes in a 'work-recovery deficit.' The capacity to finish a round, slow the heart rate and remove accumulated lactate is therefore a crucial physiological attribute that allows a fighter to go into the next round better recovered and regenerated. 'Recoverability' is a concept that represents a fighter's ability to stress his or her physiology maximally or near-maximally, and upon cessation of the exercise (i.e. round), recover the body back toward baseline levels as fast as possible. For example, if a fighter is able to lower their heart rate by 10% from max. between rounds, they would enter the next round with a 10% 'window' of relative sub-maximal work before hitting their physiological ceiling again. In comparison, if their opponent was to reduce it by 25%, they will enter the next round more recovered, working at a lower relative intensity, and with a greater window to work in before maxing out. Measuring 'recoverability' is therefore an essential consideration in MMA.

PHYSIOLOGICAL RECOVERABILITY CHARACTERISTICS BY UFC WEIGHT CLASS

	Max HR (bpm)	Max (La) (mmol/L)	1 min HR Recovery (%)	5 min HR Recovery (%)
WSW	186	10.0	17	42
WFW	193	13.0	9	32
WBW	186	12.5	11	36
FW	187	16.5	19	36
BW	183	15.0	21	44
RFW	185	14.9	15	36
LW	184	17.0	13	39
WW	186	17.0	13	39
MW	186	17.0	10	30
LHW	181	16.0	14	34

Table 5.15 Average 'Recoverability' characteristics following prolonged maximal intensity exercise by UFC weight class. (HR – Hearth Rate: bpm – beats per minute; [La] – circulating lactate concentration.

CHAPTER FIVE: PHYSICAL PERFORMANCE BENCHMARKS OF THE UFC ATHLETE

QUICK TAKES

MMA is a 'high-intensity intermittent sport in which forces must be repeatedly exerted against an external resistance in the form of an opponent'.

Reactive strength index (i.e. flight time/ contact time from 40cm box) standards should be > 2.6.

Desired maximal strength levels are > 3.5 x Bodyweight.

Desired rates of force production are approx. 40-45 N/s.

Dynamic Strength Deficit (DSD) of ≤0.60 requires more ballistic-type training; a DSD of ≥0.81 requires more maximal strength training.

Ventilatory Threshold 1 (VT1) – the point where lactate begins to accumulate in the blood.

- Desired fight-camp levels are **> 73% of VO_2max**

Ventilatory Threshold 2 (VT2) – the point at which lactate production overtakes lactate removal.

- Desired fight-camp levels are **> 86% of VO_2max**

VO_2max is the maximum amount of oxygen delivered to working muscles to support energy production.

- **UFC Women average 54-60ml/ kg/min**
- **UFC Men average 58-66ml/kg/min**

CHAPTER SIX

METABOLIC HEALTH THROUGH PERIODIZED PERFORMANCE NUTRITION

YOU CAN'T DIET YOUR WAY TO PEAK PERFORMANCE

For many combat athletes, the fight in the cage can often be less vicious than the battle which takes place in the days preceding the bout—the struggle to make weight. Difficult weight cuts at the end of a calorie-restricted fight camp take a toll on a fighter's body; particularly on their metabolic health. This becomes a critical issue when you consider that a blunted metabolism chronically impairs numerous biological systems and ultimately induces a more extreme weight-rebound. The consequence of this is often presented as more extreme and challenging weight cuts for future fights. However, working to better manage energy balance and strategically program superior fueling of the body during the weight descent and weight-cutting can largely reduce the impact that intermittent calorie restriction (i.e. repetitive "fight camp" weight descents) has on metabolism, weight-rebound, challenging future weight cuts, fighter longevity and, ultimately, long-term fighter health.

With any fighter striving to effectively and efficiently make weight, the central consideration must be the influence that fueling the body with macronutrients has on the physiology of an athlete. Indeed, it is the athlete's physiology and the way in which it intimately responds to the homeostatic insult that is caloric restriction, dehydration and elevated workload demands that will essentially determine the ease and/or effectiveness by which a target weight can be made. By adopting better fueling strategies during the weight descent and weight-cutting process—which considers essential elements like nutrient timing, macronutrient choice and the way in which nutrition interventions complement the demands of training—it is possible to reduce the impact of calorie restriction on metabolism, weight rebound and fighter health.

PERIODIZED PERFORMANCE NUTRITION

Supporting a fighter's metabolic health requires a **systematic year-round approach to fueling** that fluctuates with the flow of training and accommodates varying weight demands. This is somewhat removed from most current practices that largely acknowledge the importance of nutrition interventions ONLY during 6-10 week fight camps. Indeed, the concept of longitudinal 'nutritional periodization' that addresses the personal requirements of an individual fighter is a critical consideration when supporting the long-term physical and physiological health and performance in UFC fighters. From the outset, it is essential that the approach to performance nutrition is taken into consideration alongside the multifaceted components that go into preparing for a UFC fight (e.g. technical and tactical workloads, supplementary strength and conditioning activities, recovery and regeneration). Only when performance nutrition is considered an essential part of a larger holistic programming approach do the training demands placed on athletes, their individual recovery needs, specific weight concerns relating to their target weight, and the periodization of physical training truly get accounted for and optimized accordingly.

FIGHT CAMP NUTRITION

For the purpose of discussion here, "fight camp" will be considered as a 6-10-week period in which fighter activities are holistically directed toward a forthcoming fight. With respect to performance nutrition, fight camp priorities are:

- Weight descent through body composition optimization
- Optimize energy for training and recovery
- Provide targeted energy for skill development
- Support metabolic and general health through fight camp
- Enable performance optimization throughout camp, peaking on fight night

Far too often, fight camp becomes predominantly about losing weight rather than skill and performance development for the upcoming fight. Consequently, weight loss, rather than performance optimization, can often become the focus of consideration. Instead, nutritional strategies during fight camp are most effective when focused on supporting the energy system demands of each specific training session while also ensuring weight-loss and body composition-adaptation requirements. Nutritional timing and metabolic-efficiency fueling tactics are critical in order to support the conflicting demands of weight loss and physiological development.

It is critical to establish a longitudinal timeline for weight descent to effectively navigate a fighter down to his or her ideal fight weight within an adequate time frame to ensure that weight loss happens gradually and without significant metabolic impact; **our recommended fight night weight is within 10% over a fighter's contracted weight class.** No more than 1.5% of an athlete's body weight can be lost per week from body fat alone, so any weight descent should plan to be less severe than this in order to lose fat rather than muscle. This equates to a calorie deficit of approximately 1,000-1,500 kcals per day, which at first glance may seem severe, but when considering most fighters will be expending 3,000-5,000 kcals a day during fight camp, it still provides a reasonable amount of energy to spread across daily fuelings.

When planning the limits over which the rate of weight descent should occur, fighters and support staff should initiate the nutrition and training strategies to elicit weight descent far enough in advance of their fight to ensure a slow and steady weight descent. Importantly, moderating the rate of weight loss will help limit exaggerated metabolic disturbance of the energy deficits and allow the fighter to continue to build skill and physiological capacity throughout fight camp. Some fighters may choose to initiate their weight descent in advance of their fight camp in order to be able to re-balance the nutrition and training during fight camp, thus better enabling a focus on fighting during camp rather than having to emphasize weight loss over performance training.

To better assess weight management needs and objective insights into an athlete's medical nutrition status, the UFC Performance Institute uses a variety of technology and analytics to monitor and assess a fighter's ability to make weight and perform optimally. During fight camp, this will include:

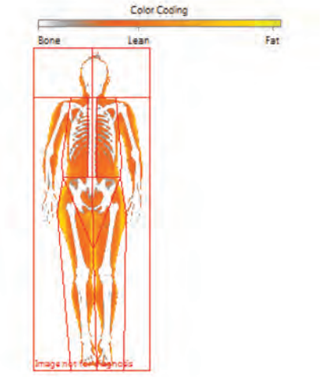
- Body Composition Analysis (DEXA, BIA)
- Resting Metabolic Rate (RMR)
- Metabolic Efficiency

DUAL-ENERGY X-RAY ABSORPTIOMETRY (DEXA)

DEXA is the gold-standard for body composition assessment. It directly measures an athlete's bone, fat and lean mass in order to analyze and track how nutrition and training tactics are affecting his or her body composition over time. Additionally, the DEXA can highlight specific bilateral tissue asymmetries that may indicate an elevated injury risk due to the imbalance (see figure 6.1).

Client	Sex	Ethnicity	Birth Date	Height	Weight	Measured

Segmental Analysis



Region	%Fat (%)	Total Mass (lbs)	Fat Mass (lbs)	Lean Mass (lbs)	BMC (lbs)
Arms Total	20.8	16.7	3.3	12.5	0.9
Right	22.8	8.2	1.8	6.0	0.4
Left	19.0	8.6	1.5	6.6	0.5
Difference	3.8	-0.4	0.2	-0.6	0.0
Legs Total	21.4	52.9	10.8	39.6	2.5
Right	21.7	26.7	5.5	19.9	1.2
Left	21.0	26.2	5.3	19.7	1.2
Difference	0.7	0.4	0.3	0.2	0.0
Trunk	15.5	71.0	10.7	58.1	2.2
Android	12.1	9.3	1.1	8.1	0.1
Gynoid	23.3	25.2	5.7	18.8	0.7
Total	18.5	151.2	26.7	117.7	6.8

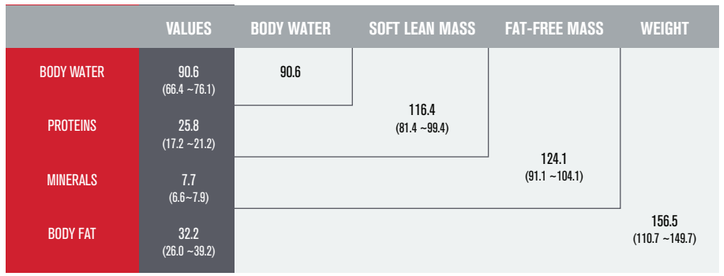
BMC = Bone Mineral Content

Figure 6.1

BIOELECTRICAL IMPEDANCE (BIA)

BIA is a method of assessing hydration status and body composition by evaluating how the body conducts and resists a low-level electrical current that is pulsed through the body. Water is a very good conductor of electricity. Therefore, when a fighter is well-hydrated, the electrical current will pass through the body with ease and at speed. However, if a fighter is dehydrated, with reduced whole-body water levels, the current will not be able to travel through the body as readily. While not quite as reliable as the DEXA in assessing body composition, it can be repeated as frequently as required and is thus very effective at providing regular feedback on the body's adaptation to nutrition and training tactics. Importantly, when considered in association with a body weight measure, BIA will give clarity on whether this is a "wet weight" or a "dry weight," such that greater understanding of the implications of the weight can be considered.

BODY COMPOSITION ANALYSIS



WHEN A FIGHTER IS WELL-HYDRATED, THE ELECTRICAL CURRENT WILL PASS THROUGH THE BODY WITH EASE AND AT SPEED.

Figure 6.2 Bioelectrical Impedance uses electrical conductance and resistance to calculate the various components of a body. This allows tracking of muscle, body fat, bone mineral and fluids (intracellular and extracellular).

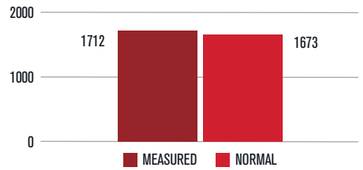
RESTING METABOLIC RATE (RMR)

RMR, sometimes referred to as basal metabolism, is an evaluation of the total number of calories an individual burns while at rest. Resting metabolism is the energy required by your body to perform the most basic functions when your body is at rest, and therefore it provides great insight as to the 'speed' at which calories can be burned. By measuring the RMR through a fight camp, we are able to observe the impact that any energy insufficiency and high training demands have on the fighter's basal metabolism. For example, we know that when RMR decreases as a result of the process of extreme energy insufficiency, the metabolic health of a fighter and his or her ability to make weight are affected long-term. Specifically, blunted RMR can impact muscle and tissue recovery, immune function, digestive health, mood and mental health, and weight regain between fights. (see figure 6.3)

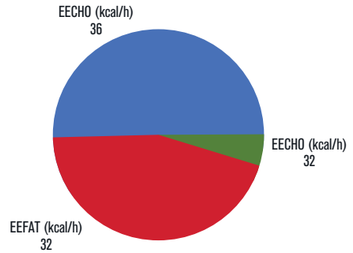
A)

RESULTS

RMR	**1712 kcal/d**
NORMAL	1673 kcal/d
RMR/WEIGHT	23.8 kcal/d/kg
RMR/BSA	936 kcal/d/m2
DEVIATION NORMAL	+2 %



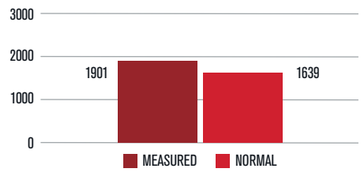
VARIABLE	UNIT	VALUE
V'02	L/min	0.25
V'CO2	L/min	0.21
RQ		0.85
RMR/kg	kcal/d/kg	23.8
RMR/BSA	kcal/d/m2	936
CHO	g/d	209
FAT	g/d	83
PRO	g/d	19
EECHO	kcal/h	36
EEFAT	kcal/h	32
EEPRO	kcal/h	3



B)

RESULTS

RMR	**1901 kcal/d**
NORMAL	1639 kcal/d
RMR/WEIGHT	27.7 kcal/d/kg
RMR/BSA	1060 kcal/d/m2
DEVIATION NORMAL	+16 %



VARIABLE	UNIT	VALUE
V'02	L/min	0.27
V'CO2	L/min	0.23
RQ		0.84
RMR/kg	kcal/d/kg	27.7
RMR/BSA	kcal/d/m2	1060
CHO	g/d	220
FAT	g/d	98
PRO	g/d	21
EECHO	kcal/h	38
EEFAT	kcal/h	38
EEPRO	kcal/h	4

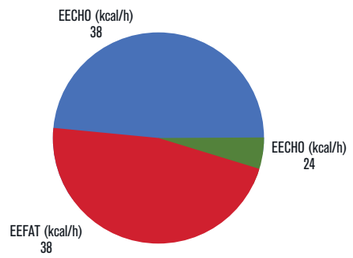


Figure 6.3 Resting Metabolic Rate assessments of a fighter entering training camp (A), and then again 6 weeks later mid-way through training camp (B) provides objective feedback that nutritional and training tactics are supporting metabolic function through weight descent.

METABOLIC EFFICIENCY TESTING

While RMR assesses an individual's capacity to burn energy at rest, it is **metabolic efficiency** that describes what source of energy he or she is best adapted to utilize at different exercise intensities. The type of energy source being used most efficiently at each exercise intensity has considerable implications on the development and transition between energy systems. For example, improved fat oxidation at rest and at moderate training intensities helps stabilize aerobic energy expenditure while preserving valuable glycogen for when it may be needed during critical high-intensity bursts of activity, or when energy becomes further depleted (see figures 6.4 and 6.5).

In some circumstances, individuals can become highly carbohydrate-adapted; meaning that even at low intensities, they preferentially utilize carbohydrates over fat as their primary fuel source (see figure 6.6). This has significant implications for MMA fighters, particularly when you consider that a primary nutrition objective of weight management is reduction of body fat levels through improved fat oxidation. In the case of a 'carbohydrate-adapted' fighter, this becomes very challenging, as the normal low-intensity cardio that would usually be used to burn off fat would actually be fueled by carbohydrate, and fat stores would remain. Furthermore, as the fighter would be primarily utilizing carbohydrates for all energetic activities, it is likely that he or she will exhaust fuel stores and have very little energy reserves to call upon during challenging workouts during fight camp. This represents a fighter who has some significant metabolic challenges, will feel tired, lethargic and under-recovered, and will ultimately struggle to positively adapt body composition during fight camp.

Other metabolic efficiency profiles include athletes who continue to use fat through moderate intensities but are very dependent on carbohydrate energy and engage the glycolytic energy system at very low intensities (see figure 6.7). But transitioning early to the glycolytic energy system as the primary energy source is likely to expedite the accumulation of lactate (often referred to as lactic acid), which is the result of anaerobic metabolism. The consequence of this will be that fighters who demonstrate these characteristics will "gas out" very quickly as training and competition demands more sustained efforts—their work capacity will be compromised by the highly fatiguing nature of elevated lactate levels. Instead, the desire should be to minimize lactate accumulation for as long as possible, which demonstrates greater bioenergetic efficiency by delaying the onset of lactate accumulation.

It must be noted that excessive fat adaptation can go too far for MMA athletes, as relying on lipids (i.e. fats) at higher relative exercise intensities can severely limit the body's transition to the high-energy anaerobic systems that are so crucial for fueling the peak power outputs required for explosive efforts such as throws, takedowns and all stand-up and striking activities (see figures 6.8 and 6.9).

BALANCED METABOLIC EFFICIENCY PROFILE: % SUBSTRATE

Figure 6.4 The Metabolic Efficiency test assesses the type of energy substrate that an athlete is using as they increase exercise intensity. This profile represents a typical fighter profile in which fat is used through low and moderate intensities and then primarily carbohydrates for higher intensity efforts. The crossover-point where carbohydrate utilization takes over as the primary fuel source can be identified above at approximately 5.6mph and a heart rate of 150bpm.

BALANCED METABOLIC EFFICIENCY PROFILE: FAT & CHO UTILIZATION (g)

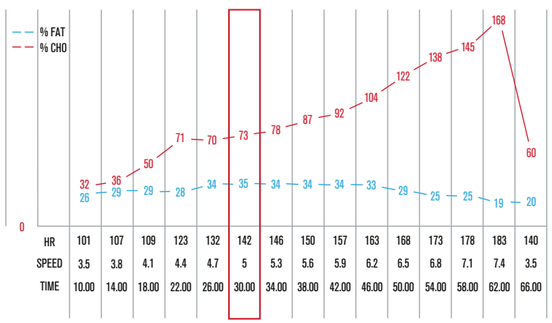


Figure 6.5 Looking at the grams of each energy substrate utilized can provide more detail into how each individual athlete is responding to increases in exercise intensity. While the amount of carbohydrates that this athlete uses increases steadily at a relatively low HR of 109 bpm, they are also able to consistently use fat as a fuel source between a heart rate of 132-163bpm. This provides a range of optimal fat oxidation that is critical for strength and conditioning professionals and MMA coaches alike to program low intensity conditioning strategies that will promote fat utilization.

CARBOHYDRATE ADAPTED METABOLIC EFFICIENCY PROFILE: % SUBSTRATE

Figure 6.6 The Metabolic Efficiency profile of an athlete who is 'carbohydrate adapted' and demonstrates a rapid transition to carbohydrates as primary fuel source at the initiation of exercise.

CARBOHYDRATE ADAPTED METABOLIC EFFICIENCY PROFILE: FAT & CHO UTILIZATION (g)

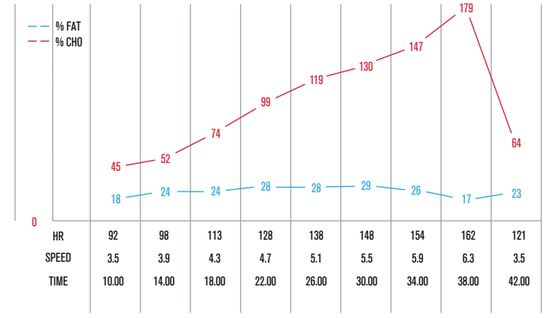


Figure 6.7 Metabolic profile of an athlete who while continuing to use low levels of fat through moderate intensities becomes very dependent upon carbohydrate energy and the glycolytic energy at very low intensities."

RMR	2034 kcal/d
NORMAL	2438 kcal/d
RMR/WEIGHT	20.0 kcal/d/kg
RMR/BSA	884 kcal/d/m2
DEVIATION NORMAL	- 17 %

VARIABLE	UNIT	VALUE
V'O2	L/min	0.30
V'CO2	L/min	0.22
RQ		0.74
RMR/kg	kcal/d/kg	20.0
RMR/BSA	kcal/d/m2	884
CHO	g/d	57
FAT	g/d	183
PRO	g/d	24
EECHO	kcal/h	10
EEFAT	kcal/h	71
EEPRO	kcal/h	4

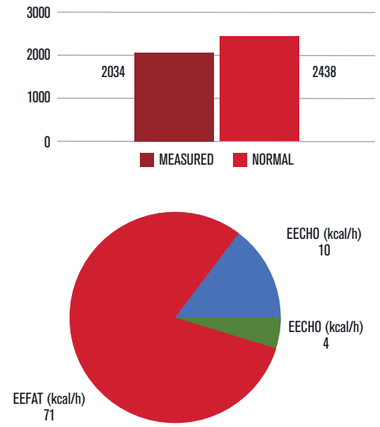
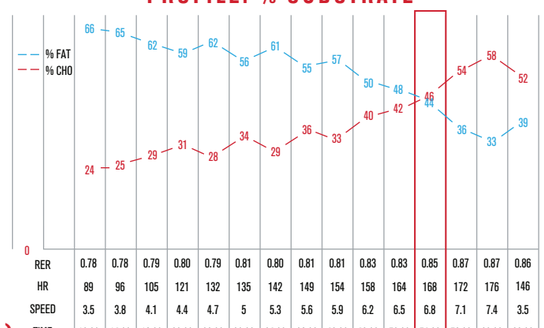


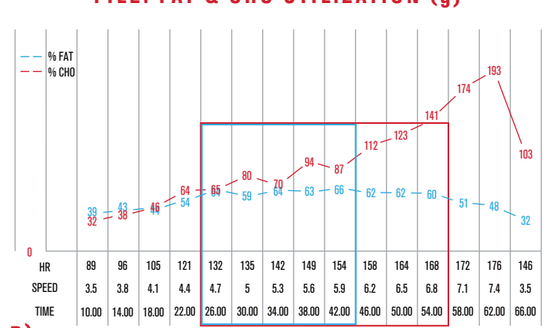
Figure 6.8 These data represent the RMR results for the same fighter as shown in figure 6.9 who is experiencing 'hypometabolism'; a drop in metabolic rate of >400 kcals/d (17%) from the predicted normal range (2438kcal/d). This fighter's extreme fat adaptation (RQ = 0.74) is a likely result of his body's restricted state and will severely limit recovery capabilities as well as impact future weight loss.

FAT ADAPTED METABOLIC EFFICIENCY PROFILE: % SUBSTRATE



A)

FAT ADAPTED METABOLIC EFFICIENCY PROFILE: FAT & CHO UTILIZATION (g)



B)

Figure 6.9 This fighter's fat adaptation during training supports using fat from both adipose stores and from diet to fuel training. This fighter switches from fat to carbohydrates as a primary fuel source at a HR of approximately 168 bpm (A) while the zone for high fat utilization is 132-168 bpm, and peak fat oxidation occurred at ~164 bpm (B). This metabolic efficiency status supports long submaximal efforts but maximal and repeated near-maximal efforts may be limited because of glycolytic energy system suppression.

FIGHT CAMP RECOVERY

Very often athletes avoid all nutritional structure after a long fight camp and weight cut, and many fighters know nothing but the restrictive dieting that they used to make weight. 'Fight Camp Recovery' is a concept of structured but flexible fueling in the weeks following a fight. With respect to performance nutrition, recovery priorities are:

- Return to metabolic balance
- Brain and systemic inflammation repair
- Maintain fueling structure while providing more flexibility in food choices
- High anti-inflammatory foods, moderate processed carbohydrates as possible
- **Duration of this period dependent upon degree of metabolic disturbance following fight camp

Any period of time with sustained under-fueling of training is likely to result in at least some metabolic impairment, which is described by the phenomenon 'Relative Energy Deficit in Sport' (REDs).

Beyond the acute metabolic and physiologic impairment that restrictive weight descents and weight cuts can have, the undernourishment often experienced during restrictive fight camps drives up the weight rebound between fights. Not only does this weight 'cycling' make achieving the desired weight class more challenging and thus nutritionally more restrictive for each subsequent fight, but it is also responsible for the development of disordered eating behaviors, including binge eating and metabolic disorders later in life.

METABOLIC REHABILITATION

While it is important to be as strategic as possible with any necessary calorie-deficit weight-loss during fight camp, it is also important to have a plan post-fight. Any fight camp that includes a phase of caloric restriction also benefits from a period of 'Metabolic Rehab' in the subsequent two or more weeks in order to support the body in optimizing its recovering metabolic function that may have been impaired during the weight-making process. This phase should not be confused with cheat meals, cheat days or anything otherwise regarded as cheating on a diet. Instead, the period of metabolic rehabilitation should be well planned and consistent, as should any other phase of performance nutrition.

Metabolic Rehabilitation should prioritize nutritional timing as well as strategic selection of nutrient type, quality and quantity; micromanaging nutrients, as may be required in weight management phases, does not belong in this training phase. Balancing nutritional intake evenly across the day is critical to regularly provide energy to support each underlying contributor to metabolism. This includes: protein for tissue repair, carbohydrates for general energy utilization and neurotransmitter development, energy and nutrients for hormone production, minimally processed fish and plant fats, especially Omega 3 for brain repair and to combat inflammation and potentially mitigate head injuries, and phytochemicals to defuse free-radicals. Ensuring approximate nutritional and caloric equivalence between the three main meals and providing a source of nourishment to **ensure no fueling gaps greater than three hours** will maximally support a fighter's metabolic rehabilitation post-fight.

The 'quantity' of nutrition during this period is also important. Anecdotal evidence indicates that approximately 120% of a fighter's predicted metabolic rate is an ideal target to nudge his or her metabolic rate back up, while accounting for any additional energy expenditure related to physical activity during this period (see figure 6.10). Compared to what many UFC fighters are eating during fight camp and fight week, this may be an overwhelming amount of food that is perhaps daunting for fighters constantly concerned about excessive weight gain. Alternatively, many other fighters may absolve themselves of any nutritional consistency post-fight and instead get into an irregular and often bottom-heavy fueling pattern in which most food is consumed at the end of the day; a bottom heavy fueling pattern neither supports tissue nor metabolic repair but instead drives up fat deposition and increased adiposity (see figure 6.11).

The balance of nutrients does not need to be micromanaged during the fight camp recovery phase, as the focus should be on fueling the body with nutritionally dense foods that provide the most nourishment and best help the body to recalibrate metabolically without dramatically overshooting the body's needs. Highly processed carbohydrates, fats and sugars are more easily overconsumed, but they also drive up the inflammatory processes that are responsible for much of the detrimental effects of training—including injury, illness, metabolic dysfunction and increased body fat development. While a balanced nutritional plan is critical to maintaining athlete compliance and well-being, a prioritization of minimally processed, nutritionally dense food is important at all phases of training, including during metabolic rehabilitation. This can and should include minimally processed components of fresh fruits and vegetables, complex carbohydrates, protein and fat sources. **An effective meal planning tactic during this phase is to include three to five similarly sized meals with approximately equal portions of protein, complex carbohydrates, colorful fruits and/or vegetables, and a quality fat source.** Ensuring a daily dose of Omega 3 Fatty Acid of 2-4 grams, either through food or supplement, has also been shown to support brain repair during the very critical post-fight period.

RMR	**2292 kcal/d**
NORMAL	1591 kcal/d
RMR/WEIGHT	35.5 kcal/d/kg
RMR/BSA	1311 kcal/d/m2
DEVIATION NORMAL	+44 %

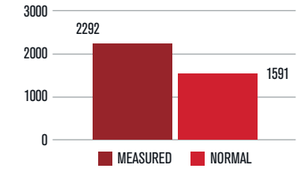
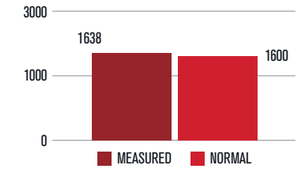


Figure 6.10 This RMR occurred post-fight following a 1-week 'Metabolic Rehab' period of unrestricted, intuitive and regular fueling which measured a +700 kcal/d (44%) variance from predicted. This fighter's training camp was successful with a fueled weight descent that allowed for steady weight loss through camp with a moderate weight cut that allowed the fighter to have a self-rated 'excellent' effort in the cage.

A)

RMR	**1638 kcal/d**
NORMAL	1600 kcal/d
RMR/WEIGHT	35.5 kcal/d/kg
RMR/BSA	1311 kcal/d/m2
DEVIATION NORMAL	+2 %



B)

RMR	**2096 kcal/d**
NORMAL	1600 kcal/d
RMR/WEIGHT	31.4 kcal/d/kg
RMR/BSA	1222 kcal/d/m2
DEVIATION NORMAL	+31 %

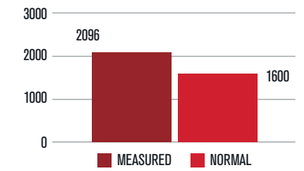


Figure 6.11 *2 weeks pre-fight* (A): At the time of this RMR, Fighter X was 2 weeks pre-fight following a long weight-loss focused training camp. This RMR is 2% higher than predicted. While this RMR was 2% higher than predicted the result of this fighter's weight descent was a mixed result as they made weight but experienced many symptoms of relative energy deficit and struggled with energy throughout camp and during the fight and had a self-evaluated 'poor' effort in the cage. *After 4 weeks of 'metabolic rehab'* (B): After 4 weeks of "Metabolic Rehab" the same fighter demonstrated an RMR that improved >400 kcals/d and was 31% higher than predicted, a 29% increase from the end of the fighters weight descent period; this demonstrates a drastic metabolic rebound and all-around improved levels of health.

GENERAL TRAINING

The time period for general training is varied based on fight commitments. With respect to performance nutrition, general training priorities are:

- Developing a performance nutrition mindset
- Building structure with 'nutritional timing'
- Balanced fueling mindset to support energy and metabolically neutral fueling
- (optional) Pre-Fight Camp Weight Management

The time spent between specific training camps is often a lost opportunity to build in a fueling foundation that can set fighters up for more consistency as they move into future training camps and fight preparation. The key fueling fundamentals for fighters to develop during this phase of training include:

1. DEVELOPING A PERFORMANCE NUTRITION MINDSET

Until an athlete commits to prioritizing nutrition as a critical training variable, the foundations that he or she is building their MMA training on will be inconsistent and unstable. Fueling with a performance purpose by adopting a year-round philosophy and recognizing the benefits that performance nutrition can offer is critical. This is also a great opportunity to develop a deeper nutritional skill-set that may include cooking, meal planning and prepping, grocery shopping, nutritional time management and gut training.

2. BUILDING STRUCTURE WITH NUTRITIONAL TIMING

Providing nourishment to the body and brain consistently throughout the day, and specifically at the moments those nutrients are most needed, helps train the body to both tolerate and accept food. On many occasions, athletes who are not accustomed to eating at specific times, typically in the morning or mid-day, do fine with this routine when training is light but struggle to maintain energy and output when training ramps up—as often seen during a fight camp. These athletes struggle to tolerate food early in the day, especially around training sessions. Gut training can help adapt tolerance to different fueling strategies around training and is best accomplished in the "Off Camp" phase, when training tends to be less extreme and rigid.

3. BALANCED FUELING MINDSET

Balanced fueling that includes even distribution of macro and micronutrients during periods of more generalized training can be impactful in rehabilitating a fighter's metabolism that may have been damaged during previous weight descents. Focusing on being energy and metabolically neutral by meeting 100% basal metabolic and training demands during this phase will be vital in supporting not only a fighter's next weight descent, but the body's continued ability to descend to a desired weight with ease and efficiency in the future.

Having balance in making food and nutrition choices is also a critical skill to develop during this phase. The 80/20 fueling philosophy speaks to this balance, as 80% of food selections should maintain a performance nutrition mindset while 20% of choices should be based on personal preferences and eating pleasure. Food is a source of joy for most people, but when turned into a matrix of macronutrients and numbers, it often is a source of torment for many fighters. Instead of falling into the trap of restricted/binge eating, fighters can maintain a respect and enjoyment of food by renewing balance during this general training phase, rather than a lifestyle of gluttony that often accompanies these periods away from the cage. Finding balance in food choices now and maintaining as much of this perspective through all phases of training can dramatically impact a fighter's quality of life.

4. (OPTIONAL) PRE-FIGHT CAMP WEIGHT MANAGEMENT

If a fighter's weight rebounds between fights to a weight that is higher than what allows them to limit weight loss during camp to 'moderate rates' as previously discussed, a pre-fight camp weight-management-focused phase may be necessary to make fight camp more manageable. If a fighter's weight descent plan for an upcoming fight camp requires more than 1-1.5% weight loss per week to be 10% over on fight night then it is advisable to train and fuel the body to within range of their fight weight prior to entering a more intensive training camp.

PRACTICAL APPLICATION

While the nutrition demands and priorities can change and must adapt as a fighter transitions through training phases, maintaining a performance nutrition focus enables for nutritional periodization to support the athlete's needs at any given phase. The major phases of nutritional periodization for UFC athletes are Fight Camp, Metabolic Recovery and General Training. Each of these phases has unique fueling demands that should be addressed on an individual level based on many variables that include nutritional and medical history, metabolic status, body composition, amount over weight class, social demands and stress, as well as countless other impacting variables.

Importantly, nutrition diagnostics can provide critical insights into how a fighter's body has adapted to nutrition and training regimens of the past and can guide nutrition and training programming moving forward. **Metabolic efficiency fueling is core to the concept of nutritional periodization for combat athletes.** This flexing of the energy substrates (i.e. carbohydrates and fats) based upon an athlete's existing metabolic efficiency, immediate training demands and weight and body composition goals, is at the center of many nutritional strategies that optimize performance and promote health and well-being. While it may be hard to make nutrition changes in the middle of a fight camp, minimizing the depth and duration of energy deficiency while making weight will set up a fighter not only for a strong performance in the Octagon, but also for metabolic health that will support them throughout their career and beyond.

CHAPTER SIX: METABOLIC HEALTH THROUGH PERIODIZED PERFORMANCE NUTRITION

QUICK TAKES

The recommended fight night weight is within 10% over a fighter's contracted weight class.

Periodized performance nutrition for UFC fighters can be separated into three major phases: Fight Camp, Metabolic Recovery and General Training.

Fight Camp should focus on weight descent and optimizing energy for training and recovery:

- **No more than 1.5%** of an athlete's body weight can be lost from body fat per week, so any weight descent should be less severe than this
- Most UFC fighters should be losing **no more than 2-3 pounds per week** throughout a weight descent
- This equates to a calorie deficit of 1,000-1,500 kcals per day if supported by a well-functioning metabolism

Metabolic efficiency is a critical consideration when determining how the body utilizes different energy sources and changing exercise intensities.

Moderating the rate of weight loss will help limit exaggerated metabolic disturbance and allow the fighter to continue to build skill and physiological capacity throughout fight camp.

Using nutritional timing and nutrient selection to restore metabolic balance. Fight Camp Recovery should prioritize metabolic rehabilitation.

CHAPTER SEVEN

THE UFC PERFORMANCE PARADIGM

HIGH ACHIEVEMENT ALWAYS TAKES PLACE IN THE FRAMEWORK OF HIGH EXPECTATION

Information and data, while at times overwhelming, can also be the greatest catalyst for change and improvement. Indeed, having information and insight allows for awareness, reflection, comparison and, ultimately, consideration as to the best pathway forward. But one of the nuances of information is that it's hard to truly understand the best approach when the whole story is not presented, or when specific pieces of information are missing. "Much like a jigsaw puzzle, without all the pieces in place, it's impossible to see the whole picture."

The same applies to sports performance; there are critical pieces of information that an athlete and coach must consider in order to be positive that their efforts are directed in the best way possible. How can you be a world champion if you don't know the level you must aspire to? How can you improve your physical standards if you don't know which areas of training are most impactful? Or how do you work to improve if you have no objective awareness as to whether you are even getting better?

These questions and many more should be at the forefront of any world-class performer. In an effort to provide answers to some of these questions, and to insert some of the puzzle pieces that were previously missing in the MMA body of knowledge, the UFC Performance Institute has shared its insights within this report; the first cross-sectional analysis of UFC fighters of its kind. Adopting a truly integrated, multidisciplinary perspective on MMA performance, we bring together every aspect that goes into success. From competition analytics to injury audits, physical benchmarks and philosophical strategies, we feel that no piece of the 'performance puzzle' has been overlooked, and these insights provide a framework upon which coaches and athletes can take their development to even greater heights.

MODELING PERFORMANCE

"Performance modeling is the abstraction of a real system into a simplified representation that enables the prediction of performance."

'Modeling' means prediction, or in simple terms, estimating the performance of a new system, estimating the impact of change on an existing system, or estimating the impact of a change of workload on an existing system. Here the 'system' is the UFC fighter, and the performance model reflects the optimal way to predict success. Performance models represent a strategic approach to minimizing risk (e.g. under-performance, injury risk) and maximizing standards of output (i.e. "best in class") by creating a framework that accounts for all the respective **'determinants of performance'** that shape success. A performance model is directly aligned to **'what it takes to win'** (WITTW) and is created by reverse engineering the components of WITTW and accounting for them in a methodological fashion.

THE UFC PERFORMANCE PARADIGM

The UFC Performance Paradigm is a reflection of all that has gone before in this cross-sectional review. It has been built by drawing upon each aspect of training and competition for MMA and is the ultimate roadmap for success in the world's most demanding arena; the UFC. The UFC Performance Paradigm is a model that has the purpose of giving coaches and athletes clear pathways to consider at every level of performance, with the intent that no stone is left unturned as it relates to what influences winning! The UFC Performance Paradigm represents the blueprint for success. Note, however, that this approach to modeling leaves opportunity for nuance and interpretation, particularly with respect to the technical and tactical aspects of MMA. Indeed, the model works to provide a holistic approach to development, yet it is almost impossible to account for every unique variable in a chaotic sport like MMA.

Figure 7.1 gives a brief overview of the primary components contained within the model. The complete UFC Performance Paradigm can be found at the back of this journal, and represents a comprehensive framework that gives any athlete, coach or support team member complete insight into the individual details that go into formulating today's UFC Fighter.

The model is built across 4 respective phases, with each phase identified for the implications it has on long-term athlete development, performance enhancement and performance optimization in the Octagon. This periodization system is unique to the sport of MMA, and particularly the professional ranks of UFC.

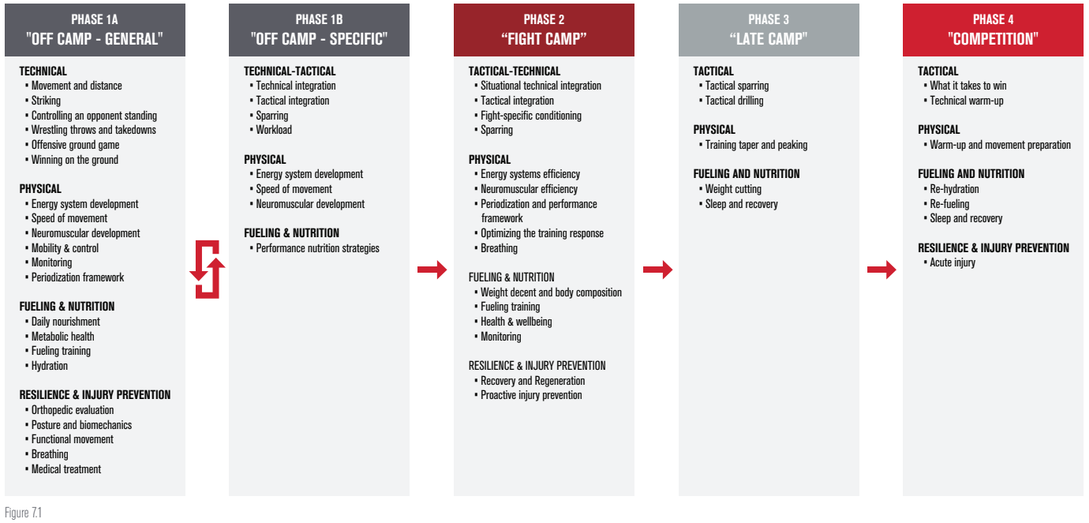


Figure 7.1

PHASE 1A - "OFF CAMP - GENERAL PREPARATION"

The ***"OFF CAMP - GENERAL PREPARATION"*** phase involves activities fighters should pursue when no fight is scheduled. Most important for the development of underlying physical qualities and the drilling and rehearsal of fundamental MMA skills, the importance of Phase 1A cannot be overlooked. Many of the attributes that simply cannot be developed during a 6-10-week fight camp must be addressed here. A TECHNICAL section prioritizes skill development over tactical aspects of MMA. The PHYSICAL section defines each of the physical and physiological parameters that should be targeted. Metabolic health and nourishment is at the center of regenerative FUELING AND NUTRITION considerations. And finally, this off-camp-general preparation phase should be the time when existing injuries are resolved, and RESILIENCE AND INJURY PREVENTION strategies are prioritized.

PHASE 1B - "OFF CAMP - SPECIFIC PREPARATION"

Phase 1B is an extension of 1A, but the focus is modified slightly to ***"OFF CAMP - SPECIFIC PREPARATION"***. Throughout the "Off Camp" period, phases 1A and 1B should be cycled as a means to promote the ongoing development of general and specific qualities. The purpose of this is to ensure that fighters commit to general development needs that will support competition standards in the long run. Yet it is important that a fighter doesn't fall too far from fight-specific conditioning, as he or she may commit to a bout at any moment; consequently, Phase 1B ensures fighters continue to get small amounts of exposure to higher-quality 'specific' preparatory work that maintains fighting skills. A TECHNICAL-TACTICAL approach can be adopted for MMA-specific training in this phase, owing to the more 'specific preparation' focus of the off-camp period. PHYSICAL training continues and is supported by ongoing FUELING AND NUTRITION considerations.

PHASE 2 - "FIGHT CAMP"

Phase 2 is "Fight Camp" and perhaps the most important phase of preparation UFC fighters give to competition. Throughout fight camp, the focus changes to a TACTICAL-TECHNICAL lead emphasis above all else. PHYSICAL training remains, and becomes and becomes focused on fight-specific conditioning with a shift to the 'realization' of training done previously in phases 1A and 1B. The FUELING AND NUTRITION focus prioritizes weight descent and delivering the fighter to weigh-ins. With training load and intensity increasing throughout fight camp, the RESILIENCE AND INJURY PREVENTION aspects focus on recovery and regeneration strategies due to the camp-based training demands.

PHASE 3 - "LATE CAMP"

Phase 3, or "Late Camp" defines two primary objectives: 1) a taper in workload that will peak a fighter for competition; and 2) the weight cut. Within the UFC Performance Paradigm, TACTICAL considerations are now the only MMA aspects addressed. PHYSICAL workload is reduced by up to 60% in order to allow for the tapering of workloads for regeneration and a peaking of performance standards on fight night. In the late camp phase, FUELING AND NUTRITION becomes the primary driver for this phase and prioritizes that fighters make weight in the most effective way possible from a health and performance perspective.

PHASE 4 - "COMPETITION"

Phase 4 is "Competition." Competition is driven entirely by TACTICAL factors. However, there are obvious PHYSICAL and FUELING AND NUTRITION components that can contribute here to maximize the physical status of a fighter. RESILIENCE AND INJURY PREVENTION considerations only become active post-fight.

PRACTICAL APPLICATION

In summary, the **UFC Performance Paradigm** is the most comprehensive approach to defining WITTW for UFC fighters. It draws upon all the insights and analytics from tactical, medical, physical and nutritional domains. The mantra of the UFC Performance Institute is to ***"Accelerate the Evolution of MMA,"*** and to do this we must share our findings in the hope that the MMA community can learn from and interpret this information to best fit their own growth and development. The UFC Performance Paradigm represents just this; the sharing of best practices and the most effective way to succeed in the UFC; and it is supported by data and evidence. We believe the UFC Performance Paradigm truly represents the blueprint for success in the UFC and, ultimately, it is the pathway that will lead all fighters to elevate their standards of performance for the greater good of the UFC and the sport of MMA.

WE BELIEVE THE UFC PERFORMANCE PARADIGM TRULY REPRESENTS THE BLUEPRINT FOR SUCCESS IN THE UFC.

CHAPTER SEVEN: THE UFC PERFORMANCE PARADIGM

QUICK TAKES

"Off-Camp-General Preparation"
when no fight is scheduled:

- Development of underlying physical qualities and the drilling of fundamental MMA skills

"Off Camp-Specific Preparation"
when no fight is scheduled:

- Exposure to higher quality 'specific' preparatory work that maintains fighting skills

"Off Camp-General Preparation" and "Off Camp-Specific Preparation" should be cycled while no fight is scheduled, allowing fighters to maintain some amount of sports-specific conditioning.

"Fight Camp" when a fight date is set:

- Focus on tactical and technical aspects with fight-specific metabolic conditioning

"Late Camp" defines two primary objectives:

- Taper in workload that will peak a fighter for competition
- Weight cut

SUMMARY

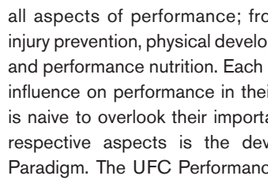
At the UFC Performance Institute we have many goals and objectives, but on a daily basis we retain three primary ambitions. Our first ambition is to provide world-leading expertise and support to UFC athletes by delivering customized services in line with the goals, needs, and requirements of each individual fighter. Our second ambition is to forge new insights around the sport of MMA so that we can gain a more accurate and comprehensive understanding of how best to prepare and ultimately win in the UFC. Our final ambition, and perhaps most important, is to openly share cutting-edge information with the MMA community. Indeed, the PI sees the need to become a conduit for sharing information as a critical role that serves to elevate global knowledge and educate on 'best practices' for the sport of MMA.

This performance review represents just that. After 12 months of working with the world's leading MMA fighters from across the globe, we wanted to mark our 1st anniversary by giving back to the community and present some of our early findings. With over 300 fighters utilizing the Performance Institute in 2017-18, we have had an opportunity like no other to gain the most comprehensive understanding of 'what makes a UFC fighter'. But this review doesn't represent the end of the story or even offer all the answers. Instead, it is the start of what we hope will become a regular dialogue that the whole MMA community will see value in. Our hope is that this early review represents a catalyst which serves to accelerate the evolution of the sport of MMA through new data, novel findings, and critical considerations. To quote Benjamin Franklin, "An investment in knowledge pays the best interest."

The UFC Performance Institute adopts an athlete-centered, coach-lead, facility-enabled, objectively-informed philosophy. At the heart of this philosophy is the belief that only by working in a truly inter-disciplinary fashion is it possible to optimize performance. For example, "how can a nutrition plan be effectively implemented without awareness of training demands"?; "is it realistic to think that a strength and conditioning coach can write a personalized plan without knowing the history or potential injury risk of an athlete"?; and "is it even possible to develop a holistic training plan without considering that MMA development is the fundamental requirement that all coaches and support team members should be working towards"?

The contents of this review have deliberately taken into account all aspects of performance; from technical/tactical strategy, to injury prevention, physical development, planning and periodization, and performance nutrition. Each of these domains has a significant influence on performance in their own right, and for this reason it is naive to overlook their importance. The culmination of all these respective aspects is the development of UFC Performance Paradigm. The UFC Performance Paradigm is the most comprehensive blueprint for MMA developed; considering not only the technical and tactical aspects of the sport, but all the other fundamental components that influence the probability of success. Indeed, the UFC Performance Paradigm represents the 'roadmap' for success. Importantly, this model presents a system that can be executed in an applied and practical fashion, yet it gives athletes and coaches the freedom to interpret this system in their own particular fashion and integrate the specifics of their own approach to MMA development.

We are very excited to share this review with the whole MMA community. We hope you find value in the information we have presented, and we look forward to building discussion and conversation around the key aspects we have covered. We also look forward to the distribution of more critical insights in the future. The UFC Performance Institute represents a resource that is available to all UFC fighters and their coaches, regardless of where they are located in the world. We look forward to continuing to support each athlete in achieving their individual goals while also providing a platform upon which we as a global MMA community can collectively accelerate the evolution of MMA by delivering 'best in class' support to UFC fighters everywhere.



DUNCAN FRENCH
VICE PRESIDENT, PERFORMANCE
UFC PERFORMANCE INSTITUTE

ACCELERATE YOUR EVOLUTION

UFC PERFORMANCE INSTITUTE WILL ACCELERATE THE EVOLUTION OF MMA BY DELIVERING INTERDISCIPLINARY SERVICES, SCIENCE, INNOVATION AND TECHNOLOGY, WHILE SHARING BEST PRACTICES FOR PERFORMANCE OPTIMIZATION WITH ATHLETES AND COACHES AROUND THE WORLD.

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