

REVIEW

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MIXED MARTIAL ARTS: A COMPREHENSIVE REVIEW

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ABSTRACT

Currently, mixed martial Arts (MMA) is one of the most popular and fastest growing sports in the world for participation as well as media consumption. Scholarly research concerning MMA is limited, but becoming an increasingly more popular area of examination. A broad search of peer-reviewed literature presents clearly defined themes of research interest; injuries and injury risk are the most popular, followed by MMA history, social perception of the sport, sports-specific training, and lastly fan motivations for consumption. Present research in this field is sparse, though the growth of MMA popularity provides evidence that future research is warranted. More specifically, the function of each of these research areas should clearly delineate the nature of this fledgling sport and diffuse social misconceptions. Research suggests that MMA injuries risk is equal to or less than other martial arts and team sports. Current sports-specific training research is preliminary and consists of no empirical training studies. Lastly, the increasing television audiences suggest the social perception is becoming increasingly favorable.

Keywords: combat sports, concussions, UFC, martial arts, MMA, fighters

INTRODUCTION

The history of mixed martial arts (MMA) originates to 649 B.C., when the sport of pankration (pan, meaning “all”, and kratos, meaning “powers”), combined the arts of boxing and wrestling (42) and was first introduced into the Olympic Games. Modern MMA is a combat sport combining traditional and non-traditional martial arts, where grappling and striking aspects are merged to create a method for competition. Despite the sport’s history, modern MMA had not become popularized in the United States until 1975 when martial artist and movie star, Bruce Lee, introduced his eclectic art, Jeet Kun Do (1). It wasn’t until 1993 that a major organization was created in the United States. This organization, known as the Ultimate Fighting Championship (UFC), formed the first modern day MMA competition, which held in Denver, Colorado. The aggressive appearance of the sport and lack of a governing body steered politicians to create sports-specific legislation, leaving an uninformed public to publish numerous articles of varying levels of accuracy. Eventually MMA notoriety garnered from events and media coverage caused the sport to be banned in all but three states, prompting financial struggles until 2000, when the UFC was purchased by Zuffa, LLC. Since then, the company has turned the UFC into a multi-million dollar brand arguably making it one of the fastest-growing sports in America. The purchase was an attempt to redefine the competition as a legitimate sport by instigating time-limits, weight classes, and rules to protect the athlete.

By 2005, the sport had gained enough commercial acceptance that it spawned its own reality show. This show, known as *The Ultimate Fighter*, was regularly aired on basic cable. By 2012, the sport finally transitioned from a banned activity to mainstream status, with FOX regularly showing events on its

main and ancillary networks. According to UFC.com, UFC broadcasting reaches 149 countries and half a billion homes in 20 different languages (www.UFC.com, 2012) and has held televised events nine countries other than the United States.

The increase in popularity has prompted a sudden increase in research surrounding MMA. Spectator motives for consumption (4, 42), personality traits of media consumers (16), and an overall increase in interest for the UFC has been the subject of previous scholarly investigation. The empirical research of MMA is limited with few studies having been published. The purpose of this study is to comprehensively review the current state of the literature and provide a foundation for future MMA research.

Methods

A literature search was conducted on PubMed and SportDiscus using the key words “mixed martial arts,” “MMA,” and “combat sports” to elicit a comprehensive list of articles in the field. The published literature related to MMA was then placed into four categories based on general themes created *a priori* after a comprehensive search for peer-reviewed research; MMA history and components, injury epidemiology, sports specific training, and social perception.

History

As early as 649 B.C., the Greeks practiced combining different martial arts in the Olympic Games and by 221 B.C., striking and grappling techniques were practiced by the military and for sport in China. The principle philosophy behind MMA development was to create a set of martial skills to prepare an individual for any combat situation, whether in the ring or on the battlefield. MMA tactics draw heavily from

Muay Thai, Brazilian Jiu Jitsu (BJJ), wrestling, and boxing. Countries throughout history have developed martial arts systems based on these similar striking and grappling concepts. Some reviews (22, 24) have explained that the development of Eastern and Western combat arts initially took place autonomously of each other until the 20th century. In the 1960's more fervent martial artists perceived the competitions within the sport to be too restricted by rules and that they inadequately tested combat skills (15). It was not until Bruce Lee popularized martial arts in the West that a modernized MMA training philosophy was realized (30). From his experience, Lee believed that a complete fighter needed to combine multiple disciplines with strength and conditioning techniques. By 1993, MMA was brought closer to mainstream with the formation of the UFC. The purpose of the original UFC tournament was to pit the many different martial art styles against one another in one tournament. The UFC created a series of competitions combining martial artists from different disciplines together into a single tournament. The tournament had very limited regulations and no official governing body. However, limited rules were applied that prohibited biting, eye gouging, fish-hooking and strikes to the groin, though subsequent events later allowed attacking the groin. The perceived violence of the sport contributed to it being banned in 30 states, and was viewed as nothing more than organized street fighting or "human cock-fighting" according to Senator John McCain (29). The sport repositioned itself in 2001 by creating a new list of 31 fouls, five weight classes, and eight possible ways to end fights (<http://boxing.nv.gov>, last accessed January 2013). Currently, the UFC exists as the premier fight promotion organization and has become a multi-million dollar company, merging with *Pride* of Japan and *Strikeforce*

in America to facilitate the standardization of MMA contests.

MMA Components

Bruce Lee drew from Chinese Kung Fu, Western boxing, Muay Thai, French savate, Korean taekwondo, Japanese judo, and Brazilian jiu jitsu as well as others to create his own fighting system (30). Since that time, MMA practitioners have evolved the sport into a hybridization of fighting styles and respective schools for training specific disciplines. This is evident as contemporary MMA discusses fighters' strengths or approaches rather than fighters' various disciplines (22). It has become commonplace for current elite fighters to write books explaining the nuances of their personal styles. For example, Author Bolleli has collaborated with former champions Lyoto Machida (10) and BJ Penn (9) to publish works on various personal fighting styles. Bolleli has gone on to review many of these books as well as help differentiate the various styles of grappling associated with MMA (8).

Injury Epidemiology

MMA is seen as independent in research and literature when compared to other contact and combat sports as being especially violent. This perception seems to be based more on emotion than evidence as seen in recent legislature to ban MMA in Canada (6) and England (46). It does not help counter arguments when conflicting results of injury prevalence and incidence rates are found in published research. In a 10-year review of injuries, it was found that during 642 matches, $28.3 \pm 3.4\%$ of were stopped due to "significant" blunt force to the head (14). It should be noted that these data did not differentiate between trauma to the head and concussion, and there was no mention of the more stringent rule changes in 2001 to help

improve safety of the fighters. Furthermore, a study in 2006 discussed the incidence of injury in professional MMA competitions during a 5-year period (7). Bledsoe and colleagues (7) examined injury incidence and prevalence after the stringent rule changes of 2001. Bledsoe examined medical and match outcome data from the Nevada Athletic Commission from 2001-2004 and found that there was a lower concussion rate of incidence for MMA than that of boxing. The most common injuries seen in MMA were facial lacerations followed by broken hands. A later article published in the British Journal of Sports Medicine examined injury trends in MMA within a retrospective cohort study from 2002-2007 (35). Ngai and colleagues found during this 5-year period, regulated MMA event injuries were similar to other combat sports, with only 3% of matches ending in concussion. In contrast, an article looking at National Electronic Surveillance data was examined comparing MMA and other "contact" and team sports to determine injuries related to their respective sports (36). MMA was found to have 65% more injuries than boxing, though only 1.6% of injuries requiring hospitalization.

Other observational injury prevalence reported in MMA literature were joint or ligament damage (5, 43) auricular hematomas (38), herpes gladiatorum (HG) (26), and tympanic membrane ruptures (19). Fields et al. (19) reported overall injury rate in MMA competitions similar to that reported of other full contact martial arts competitions. Injuries during MMA were reported to occur slightly more often than in taekwondo, but less often than reported in professional boxing, kickboxing and karate tournaments (19).

To better assess neurological injuries during competition, a sports-specific concussion test was recently developed and tested on combat athletes. The test, known as the King-Devrick (K-D) test, measures the speed of rapidly identifying numbers from three test

cards (21). The rationale behind the K-D test was to develop a "rapid concussion-screening tool by examining the physical manifestations of reduced brain functions" (e.g. impaired eye movements, attention, and language). During the trial, Galetta et al. (21) examined boxers and MMA fighters (N=39) during sparring sessions using the K-D test. Post-fight scores were significantly different (i.e. significantly worse) for individuals with trauma to the head during the match (59.1 ± 7.4 versus 41.0 ± 6.7 seconds, respectively, $p < 0.001$). Participants knocked unconscious showed the greatest decrease in test performance from pre-fight to post-fight, with higher (worse) post-fight K-D scores ($r(s) = -0.79$, $p = 0.0001$) and greater worsening of scores ($r(s) = 0.90$, $p < 0.0001$). Researchers further validated the K-D test by comparing test results to an existing criterion meant for military head trauma, known as the Military Acute Concussion Evaluation (MACE)(20). Overall, the K-D test results correlated well with post-fight MACE scores. Researchers concluded the K-D test a valid and reliable method for quick concussion screening for athletes in combat sports.

Sport-Specific Training

Though it has yet to be empirically established, it is evident that the preponderance of elite professional mixed martial artists today are highly conditioned athletes. Many of these athletes employ professional strength and condition coaches to help them with this endeavor. However, due to the dynamic nature of MMA (i.e., needing to optimize, speed, power, muscular endurance, aerobic endurance, bodyweight/composition, etc.) designing and implementing strength and conditioning programs with many factors must be considered. Additionally, designing strength conditioning programs for these athletes is complicated by multiple factors. Some of these factors complicating sports-specific

training are: existing injuries, inconsistent schedules, variable recovery times, and competing for time with other coaches. All of these aforementioned factors make designing strength and conditioning program for the mixed martial artist challenging.

The paucity of intervention and observational based research of professional mixed martial artists is due in part to the small number of professional fighters, particularly at the elite level, and gaining access to them. Additionally, getting elite mixed martial artists to participate in intervention based studies is difficult due to these athletes typically do not want to chance having their performance, or outcome of a fight, affected in any way by a researchers' "experiment" or "protocol". The focus of this section is not to elucidate all aspects of developing a performance enhancement protocol for mixed martial artists. Rather, this section will attempt to examine the relatively scant evidence existing on this topic and provide basic guidelines for enhancing overall performance for a mixed martial artist. A number of detailed reviews specifically of training methodologies and considerations have been conducted (28, 31, 37, 40).

Preliminary observational studies acknowledge MMA as a physically demanding sport requiring high volume strength and conditioning training (2, 28). In a review article by La Bounty and colleagues (28), strength and conditioning considerations were consolidated using available research on MMA sports-specific training. The purpose of the article was to discuss the available research articles on strength and conditioning for MMA. La Bounty and colleagues cited 2 studies in the area of sports-specific training. Amtmann (2) looked at self-reported training methods, though the study did not distinguish whether the athletes were professional or amateur. The majority of the fighters surveyed in this study (25 out of 28 participants) revealed that they participate in

some kind of resistance training. The frequency and training specificity varied throughout the survey results. Because of the various components that are combined for MMA, it is inferred that MMA is a physiologically demanding sport, challenging the physiology of the body and all of the energy systems. Training for MMA has raised concerns of overtraining due to the intense nature of the sport and the lack of sports-specific guidelines (3).

When considering sports-specific training programs for MMA, it is also important to note fitness and descriptive variables such as oxygen consumption (VO₂), strength, and flexibility. In a comparative physiological profile study, Schick et al (39) examined 11 male MMA fighters. Multiple descriptive and performance measures were collected from fighters, including body composition, vertical jump, flexibility, grip strength, VO₂max, and relative maximum upper and lower body strength. The findings from these tests of MMA fighters were then compared to judo, Kung Fu, kick boxers and wrestling practitioners. Results indicated that male MMA fighters had similar body fat percentage ($11.7 \pm 4.0\%$) to judokas ($11.4 \pm 8.4\%$), but greater than wrestlers ($7.6 \pm 3.4\%$) and kung fu fighters ($9.5 \pm 6.3\%$). Their VO₂max (55.5 ± 7.3 ml/kg/min) was comparable to wrestlers (54.6 ± 2.0 ml/kg/min), but greater than judokas (48.3 ± 8.1 ml/kg/min) and less than kick boxers (62.7 ± 3.6 ml/kg/min). MMA athletes were less flexible (30.3 ± 10.6 cm) than kung fu athletes (45.5 ± 6.1 cm) but were as flexible as wrestlers (30.8 ± 5.8 cm). MMA fighters (57.6 ± 7.3 cm) had less vertical jumping abilities than wrestlers (60.0 ± 10.0 cm).

According to self-reported training methods, Amtmann, (2) found that 25 out of the 28 athletes supplemented their training with strength training. Strength training frequency ranged from 1-7 times per week, and overall frequency of fight-style specific training

session ranged from 3-12 times per week. Five out of the 28 athletes reported to use or have had used anabolic-androgenic steroids. Twelve of the MMA athletes did not perform exercises specifically for the neck musculature, and only eight used the power clean and/or power snatch within their strength-training program. The results suggest that MMA athletes have a need for strength and conditioning education, in regards to balanced training, effective exercises, and the side effects of anabolic androgenic steroid use.

Other related research in the area of sports specific training focuses more on the muscles stimulated in sports-specific activity, shedding light on potential exercise considerations. McGill et al. (34) recruited five elite MMA athletes for participation in a muscle activation study. Electromyography (EMG) and three-dimensional (3D) spine motion was measured using a variety of strikes. Many of the strikes intend to create fast motion and finish with a very large striking force, demonstrating a “double peak” of muscle activity. An initial peak took place with the initiation of motion with a second peak observed upon contact with a heavy bag. Observation of the contract-relax-contract pulsing cycle during forceful and quick strikes suggested that it may be beneficial to consider this type of training, involving not only muscle contraction rate but also the rate of muscle relaxation.

To determine the proper program design for MMA athlete strength and conditioning, you must first define the specific requirements of each individual sport. It is widely published and accepted that athletic performance can be enhanced when utilizing sports-specific training regimens. Because of the specific demands of MMA, a proper training program needs to be both anaerobically and aerobically demanding. Competitions in combat sports may last from mere seconds to 25 minutes. A full length MMA fight can

challenge all three of the body's energy systems (ATP-PCR, glycolytic, and aerobic). According to fightmetric.com, the official statistics provider of the Ultimate Fighting Championship, the average MMA bout lasts 1.8 rounds, or approximately 9 minutes (37). More specifically, Del Vecchio et al. (18) reported in their findings that on average fighters will perform 6-14 seconds of high-intensity actions followed by 46-62 seconds of low-intensity efforts plus combat interruption. Although more work in this area is needed, these data provide some preliminary insight into what a “average” fight may entail, as well as certain points to consider when formulating a strength and conditioning programs.

When applying sports-specific concepts to MMA training, exercise intensity is arguably one of the most important variables to consider. However, due to the limited research investigating MMA, strength and conditioning professionals often rely upon the data from other combat sports such as Muay Thai kickboxing, wrestling, etc., when formulating exercise plans. Nevertheless, a limited number of empirical based studies have examined exercise intensity variables that exist in MMA. In 2008, Amtmann and colleagues studied the metabolic demands of MMA and the effects of employing three different interval training methods to prepare athletes for the physiological stress of a mixed martial arts match (3). All participants performed a total of six interval training sessions over the three week intervention. Additionally, blood lactate measurements and rating of perceived exertion (RPE) were assessed during the interval training sessions and immediately following (i.e., within two minutes) their actual fights. More specifically, the three different interventions that were utilized were: 1) MMA specific actions including shadow boxing and wrestling combined with high intensity movement such as push-ups, pull-ups, jump

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squats, etc.; 2) two separate four minute rounds of MMA sparring; and 3) a cycle ergometer protocol utilizing a eight repetitions of 20 seconds of maximal intensity cycling followed by 10 seconds of submaximal work (4 minutes total). Training lactate measurements ranged from 8.1 to 19.7 mmol·L⁻¹ with training RPE levels ranging from 15 to 19 on Borg's RPE scale (6-20 scale) (11). The post-competition lactate measurements ranged from 10.2 to 20.7 mmol·L⁻¹, with the post-competition RPE measurements ranging from 13 to 19. Though only four total subjects were observed during this study, the investigators concluded that the interval training protocols they utilized appeared to be an effective way to metabolically prepare the majority (i.e., three) of the athletes for an MMA match. Furthermore, results indicated using RPE and lactate were reliable in measuring exercise intensity in MMA. It should be noted that the sample size in this study was relatively small (n=4) and the investigators only monitored these athletes for three weeks prior to their actual fight (2). However, it is not uncommon for an athlete's training camps to start six weeks or more prior to the competition. It should also be pointed out that some mixed martial artists stay in relatively good condition and maintain their bodyweight between their fights. Conversely, some of these athletes are known for allowing themselves to become relatively deconditioned and in some cases gain significant amount of body mass between competitions. Thus, it is not known what these particular athletes' initial bodyweight/body composition status, baseline strength and conditioning levels, and training methodology were prior to the three week interval training intervention.

Although, there are limited energy demand data in MMA athletes, existing research in other combat sports can be used to estimate some of the metabolic demands of MMA.

MMA combines aspects of various striking arts (karate, Muay Thai, etc.) with grappling based disciplines such as freestyle wrestling and Brazilian jiu-jitsu to name a few. Muay Thai kickboxing is a very physiologically demanding sport and is one of the primary striking arts utilized by the majority mixed martial artists. Thus, examining the physiological demands of Muay Thai may help partially reveal the demands of MMA. Crisafulli et al (17) reported that in a three round simulated Muay Thai match (consisting of three minute rounds each separated by one minute), significant contributions of both aerobic and anaerobic systems were required. More specifically, anaerobic glycolysis was dominant early in the fight, but decreased steadily after the first round; while a concomitant reliance on aerobic metabolism progressively increased as the match continued (17). To improve performance in this sport, the authors suggest incorporating exercises to enhance both aerobic and anaerobic systems (17). Other studies investigating grappling based arts such as wrestling, have shown blood lactate levels as high as 20 mmol/L following a five minute college freestyle match (27). These values approximate what Amtmann et al (3) reported in mixed martial artists immediately (within two minutes) following a MMA bouts that lasted the entire regulation time (i.e., went to a judge's decision).

In their recent examination of MMA athletes, Del Vecchio et al (18) examined what they described as the "effort-pause (EP) ratio" in 26 MMA matches. The investigators concluded that the EP ratio of MMA matches ranged from 9:1 to 6:1. However, when the high-intensity efforts were compared to low-intensity efforts plus pauses it decreased to 1:2-1:4. The investigators reported these ratios were intermediate to values previously found in grappling based arts (wrestling and judo) and striking based arts (i.e., taekwondo and karate) (18). Thus, this EP ratio could be

loosely related to a work-rest ratio. As result of this aforementioned study, along with the work by Amtmann et al. (3), it suggests that high intensity interval training is probably efficacious for enhancing fight specific conditioning. In the Amtmann study (3), the authors did not report specific work-rest ratios in two of the three interval protocols. On the other hand, the cycle protocol they employed closely mirrored Tabata's cycle ergometer protocol (44) and equated to a work-rest ratio of 2:1. (18). Tabata et al. (44) demonstrated that performing moderate-intensity endurance training (~70% VO₂ max) for 60 minutes five days a week did increase VO₂ max by ~5 ml/kg/min, but did not improve anaerobic capacity. Conversely, performing high-intensity intermittent training (7-8 sets of 20 seconds of 170% of VO₂ max on a cycle ergometer followed by 10 seconds rest) not only significantly improved VO₂ max by ~7 ml/kg/min, but also enhanced anaerobic capacity by 28%. This work-rest ratio may be significantly more strenuous than the 1:2-1:4 ratio that was observed in the study by Del Vecchio et al (18). Burgomaster and cohort (12) had participants perform 4-6 maximal intensity Wingate tests (30 seconds) with 4.5 minutes between sets three times a week. They compared these subjects with another experimental group that performed more moderate intensity continuous cycling protocol (40-60 minutes) five days per week. The authors concluded that even though the high intensity group only spent about 1.5 hours a week exercising, compared to 4.5 hours spent in the moderate intensity group, both protocols produced similar improvements in mitochondrial markers of both carbohydrate and lipid oxidation, as well as glycogen and phosphocreatine utilization (12). Other studies investigating the effects of high intensity training have also reported positive results in enhancing various aspects of exercise performance (13, 23, 32).

It is clear that MMA can potentially tax both aerobic and anaerobic energetic pathways and both should be trained in order to optimize an MMA athlete's potential. However, with the existing available research, high intensity interval training appears to enhance various aspects of both anaerobic and aerobic performance. Equally important, high-intensity interval based training accomplishes this goal in a significantly less amount of time as compared to moderate intensity, longer duration exercise. Even though the benefits of high intensity interval training are well established, some combat athletes prefer to occasionally periodize low intensity exercise sessions into their training regimens. Lower intensity, aerobic based exercise such as jogging, swimming, cycling, etc. are used by some combat athletes during "light" conditioning or active recovery days. It could be argued that these "lighter" or "recovery" days, if used sparingly, add variety to an athlete's overall training regimen and may theoretically minimize psychological staleness of the athlete. Interestingly, Wilson and colleague's meta-analysis of concurrent training (47), reported that running, but not cycling, appeared to result in significant decrements in hypertrophy and strength in those that concurrently trained. Therefore, if low to moderate intensity, aerobic based exercise is occasionally employed in the training protocol of mixed martial artists, jogging appears to be a one of the least optimal modalities. Thus, "road work" (i.e., longer duration, moderate intensity jogging) traditionally utilized in boxers and other combat athlete's training regimens, should only be used sparingly or possibly not at all. Ultimately, taking the preponderance of the existing literature, it appears that the conditioning specific training devoted to prepare a mixed martial artist above and beyond their skill-specific training, should primarily focus on high-intensity interval training.

Lastly, to our knowledge, there have not been any peer-reviewed studies investigating the effects of various periodization models specific to mixed martial artists' strength and conditioning programs. Unlike many other sports, a mixed martial artist does not always know when their next competition will be, as there is not a "season" for fighting, per se. Thus, taking these points into consideration, it is prudent to utilize an undulating (non-linear) form or periodization as opposed to a linear model (28). In conclusion, much more research is warranted to elucidate strength and conditioning methodologies to optimize various aspects of performance, recovery, and injury prevention.

Motives for Consumer Consumption of MMA

A limited amount of research concerning fan motivations for consumption has been conducted. The importance of growing literature that focuses on the consumer allows for an inward-outward perspective of this growing field of research. Comparing what practitioners believe about the sport to what consumers believe add additional opportunities for researching in this field. Currently, research has examined the consumption motivations, demographics, financial affluence, and personality traits of consumers of mixed martial arts.

Seungmo et al. (42) discussed the spectator motives at an amateur MMA event, finding that the general audience for an MMA event were young males, with post high-school education, and relatively affluent (>\$50,000). Although violence is a large part of MMA as a sport, it was only seen as the fifth highest rated motive, illustrating that consumers appreciate the aesthetics and drama more than the violent nature of the sport. The findings of Seungmo et al. contradict critical claims of a lower-class spectator base of MMA (42).

Another article by Seungmo et al. (41) examined MMA spectators' motives in two of the world's largest MMA markets: the USA and South Korea. UFC events draw higher ratings than the NBA, NHL, and MLB for key demographics; setting pay per view records by generating more than 200 million dollars in 2006 in the US alone (25, 45). Similar to the UFC, MMA promoters such as K-1 found in South Korea, sold for 30 million dollars (42). The goal of Kim and colleagues was to investigate the differences among fans by comparing motives and media consumption behaviors of 437 spectators attending a local MMA event in either the US (n=208) or major metropolitan area (n=229). Researchers found that significant predictors for American media consumption were sport and athlete interest and drama with South Korean spectators drawn to sport interest, drama and adoration for primary motives of media consumption. The authors found that differences between the USA and Korean demographics could be attributed to cultural differences and educational background in martial arts.

Andrew et al. (4) explored the impact of nine motives on media and merchandise consumption among consumers of MMA. Investigators used a 43-item questionnaire, measuring potential gender differences in spectator motivations and media consumption. Researchers discovered statistically significant differences among spectator motives between males and females. Linear regression revealed significant relationships between sex-specific spectator motivations and media and merchandise consumption. The results from Andrew et al. suggest using sex-specific marketing strategies for the greatest impact on MMA consumption of media and merchandise.

A study by Choong Hoon et al. (16) looked at personality and the relationship with MMA and media consumption. Choong Hoon utilized the hedonic paradigm model to

examine if emotions intercede the relationship between personality type (i.e., risk taking) and attitude toward MMA. Their study also examined sport-media consumption (e.g., television) of MMA. The use of structural equation modeling to examine risk taking, pleasure, arousal, attitude, and actual consumption behavior found that emotion (pleasure and arousal) significantly mediated the relationship between personalities (risk taking and attitude). A conceptual model to explain the relationship among fan personalities, emotions, and MMA consumption suggested individuals with “sensation seeker”, or “risk taker” personality traits are more likely to enjoy violent media content (33).

Ball and Dixon (6) discussed that much of the negativity MMA has garnered in popular literature is anecdotal and unfounded. Ball and Dixon went on record stating a physician’s opinions need to be evidence-based, not emotion-based concerning their perception of MMA. The investigators go on to compare MMA to other popular international sports, stating:

“Horseback riding, rugby, hockey and football also possess a substantial risk of neurologic injury. Furthermore, when the actual number of participants within each activity is accounted for, the total number of injured patients, and therefore the impact on health systems and the economics of society, dwarf the small number of injuries among few MMA combatants. Any one of these other activities, when viewed through a public health prism, could easily be classified as a health emergency (6)”

It could be argued that within the rules of a potentially hyper-violent sport, education of officials and athletes is paramount in injury prevention. Many of these athletes (professional, and many amateurs) are medically screened with annual physicals, eye

exams, blood work, and magnetic resonance imaging (MRI) among several other annual exams prior to and post-competition when requested. The current protocol for professional and amateur fights mandates suspension of athletes for various periods of time if a concussion or traumatic brain injury is detected. Suspension duration of athletes varies based on severity of the injury.

Conclusion

It is immediately apparent that there are no available prospective observational studies to assist us upon review of the objective evidence. In fact, the current literature is limited to case studies describing primarily orthopedic injuries, as well as two retrospective reviews of five and seven year experiences in popular MMA regions. While it would be both naïve and inaccurate to suggest MMA fighters are not exposed to a risk of injury, the data indicates concussive head trauma does not occur as frequently in MMA as it does in boxing (7). Currently, there are no long-term data to draw conclusions. As a result of the grassroots nature of MMA development, a working relationship of ringside physicians, commission inspectors, referees and educated athletes has been established. This consortium of professionals has come together to address the growing health concerns and controls necessary to regulate the sport. It is hypothesized that with more empirical studies to draw from, event sponsors and organizational authorities can make better decisions on rules and regulations.

Additionally, future research should examine the physical requirements necessary for MMA participation and sports-specific training. Preliminary research has compared MMA athletes with judokas, wrestlers and kung fu practitioners using multiple physiological variables (39). Results from this research show similarities in body types

between these athletes, and unique demands and training adaptations specific to MMA. Research has listed aerobic training as a major part of MMA athlete training, but there have been no empirical studies providing rationale or the effects of such training on performance. Future research could look at observational metabolic and cardiovascular demands of MMA training and competition. As MMA athletes have no true “season”, it’s important to examine a general “fight camp” period of training (preparatory training immediately prior to competition) of fighters to determine optimal performance-enhancing considerations for training.

From the standpoint of social motivation, future research could focus on markets where MMA has experienced growth, such as Japan and the UK, to better understand MMA growth. While these countries have seen significant exposure to the sport, research could be expanded to examine areas that have not been exposed to the sport, to better understand how to develop into new areas. In addition to understanding the motivations for consumption, researchers should consider the antecedents of attraction towards this sport including social and psychological identification traits.

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