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DEHYDRATION AND ACUTE WEIGHT GAIN IN MIXED MARTIAL ARTS FIGHTERS PRIOR TO COMPETITION

A Thesis
by
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Submitted to the Graduate School
Appalachian State University
In partial fulfillment of the requirements for the degree of
Master of Science in Exercise Science

May 2012
Department of Health, Leisure and Exercise Science

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FOREWORD

The research detailed in this thesis will be submitted to *Medicine & Science in Sports & Exercise*. The thesis has been prepared according to the guidelines set forth by the Graduate School of Appalachian State University.

ABSTRACT

DEHYDRATION AND ACUTE WEIGHT GAIN IN MIXED MARTIAL ARTS FIGHTERS PRIOR TO COMPETITION (MAY 2012)

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The purpose of the investigation was to characterize the magnitude of dehydration and rapid weight gain (RWG) in mixed martial arts (MMA) fighters prior competition. Urinary measures of hydration status and body mass were determined ~24 h prior and then again ~2 h prior to competition in 40 MMA fighters (Mean ± SE, age: 26 ± 1 yr, height: 1.77 ± 0.01 m, body mass: 75.8 ± 1.5 kg). RWG was defined as the amount of body weight the fighters gained in the ~22 h period between the official weigh-in and the actual competition. On average, the MMA fighters gained 3.40 ± 2.18 kg or 4.4% of their body weight in the ~22 h period prior to competition. Urine specific gravity (Usg) significantly decreased ($P <$ 0.001) from 1.028 ± 0.001 to 1.020 ± 0.001 during the rehydration period. 39% of the MMA fighters presented with a Usg of greater than 1.021 g/ml immediately prior competition indicating significant or serious dehydration. In conclusion, MMA fighters undergo significant dehydration and fluctuations in body mass (4.4% avg.) in the 24 h period prior to competition. Urinary measures of hydration status indicate that a significant proportion (39%) of MMA fighters are not successfully rehydrating prior competition and subsequently are competing in a dehydrated state. Weight management guidelines to prevent acute dehydration in MMA fighters are warranted.

ACKNOWLEDGMENTS

I would like to thank my mentors, Alan C. Utter, Dave Morris, and Scott Collier for their guidance and support in my graduate studies at Appalachian State University. To all other staff of the Exercise Science graduate program, I express my gratitude for your involvement in my learning. To my fellow graduate students, I thank you for your friendships over the past two years and look forward to opportunities that may bring us together in the future.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

Introduction and Literature Review

Mixed Martial Arts (MMA) is a complex combat sport that integrates many fighting styles including boxing, wrestling, judo, muay thai, and brazilian jiu-jitsu as its main components. MMA was introduced to the United States on November 12, 1993 in Denver, Colorado (Bounty, Campbell, Galvan, Cooke, & Antonio, 2011). Soon after, violent content and health concerns of MMA prompted state governments in nearly every state to enact policy to ban the sport. Legislature in one such state, North Carolina, passed the "Ultimate Warrior Law" in 1995 banning MMA after UFC #5 was hosted in Charlotte. Recently, MMA organizations in collaboration with local government have made extensive health and safety related rule changes, which have led to the legalization of MMA in the majority of the United States. Subsequently, this has resulted in an elevated popularity of the sport and as such, MMA is now viewed as a legitimate sport, with its athletes considered as true professionals.

All competitors in MMA are required to attain a specific body weight (weight class) prior to competing in a regulated bout. The purpose for weight classes is to match athletes that are of similar size in order to create an equal playing level and minimize the risk of injury between opponents. Similar to MMA, the sport of wrestling also uses weight classes for competition. Previous studies with wrestlers have shown that mandating weight classes can lead to participation in acute rapid body water loss and dehydration just prior to competition (Centers for Disease Control and Prevention [CDC], 1998; Kiningham & Gorenflo, 2001; Marquart & Sobal, 1994; CDC, 1998) by means of excessive

exercise, sweat suits, and extreme environments. The strategy of acute rapid weight loss is used in hope of gaining a competitive advantage of strength and power over an opponent who does not reduce weight to meet the same weight class.

Rapid weight loss can lead to extreme acute dehydration. Dehydration or excess body water loss has negative physiological consequences that impair performance and can be hazardous to health. These adverse effects include impaired glycogen utilization, central nervous system dysfunction, and increases in core temperature and cardiovascular strain (Cheuvront, Carter, & Sawka, 2003). In 1997, water loss levels ranging from 6.7%-10% of body weight contributed to heat-related deaths in 3 collegiate wrestlers (CDC, 1998). The deaths of these three wrestlers brought much attention to the unsafe rapid weight loss measures, which ultimately led to regulation rule changes in collegiate wrestling; including manipulation of weight classes, week-to-week weight loss limits, body composition assessment, validation of minimal competitive weight class through body composition (B.C.) assessment, and prohibiting extreme rapid weight loss methods ("Committee Refines Wrestling Safety Rules," 1998). The new regulations were later investigated for their effectiveness and were reported to be successful by minimizing unhealthy weight loss of collegiate wrestlers (Oppliger, Utter, Scott, Dick, & Klossner, 2006).

Another issue of concern for MMA fighters, is a potential increase in risk of brain injury by virtue of blunt traumatic strikes to the head while dehydrated during competition. Previously, moderate dehydration (2.1% - 2.6% of BW) has demonstrated a significant correlation (P=0.007) between the degree of dehydration and a decrease in the ventricular volume of the brain (Dickson et al., 2005). Results of this study suggest that changes in the volume of the brain may negatively act on the outcome of traumatic brain injuries. After a

forceful impact to the head the brain will travel further within the cranium before it meets the skull if the subarchnoid space is enlarged relative to a normally hydrated state (Dickson et al., 2005). Consequently the brain will accelerate to higher velocities and this may increase the likelihood of traumatic contusion injuries after strikes to the head sustained in MMA by a punch, kick or knee.

The effects of moderate dehydration alone also create concussion-like symptoms such as imbalance, feeling slowed down, fatigue, and headache (Patel, Mihalik, Notebaert, Guskiewicz, & Prentice, 2007). In addition, moderate dehydration has shown to negatively influence postural stability and neuropsychological function during exercise (Derave, De Clercq, Bouckaert & Pannier, 1998; Szinnai, Schachinger, Arnaud, Linder & Keller, 2005). Taking these factors as a whole, a dehydrated fighter with compromised balance, alertness, reaction time, and cognitive function could subsequently be more susceptible to strikes to the head that in normally hydrated state may not occur. Coupled with potential decreased brain volume and increased risk of traumatic brain injury, it is possible that MMA fighters entering the ring in a dehydrated state can increase their risk of an adverse medical event above that which may be normally expected during a competitive MMA bout.

MMA athletes, like amateur wrestlers employ similar tactics, such as, dehydration, to lose weight prior to competition. Theses similarities combined with the similarities of competition suggest that the concerns for amateur wrestlers should also be extended to MMA athletes. This anecdotal evidence stems from the same beliefs possessed by coaches and athletes that competing in a weight class lower than one's natural body weight will result in a significant competitive advantage. For competitive MMA events, the official weigh-in is typically held 10-24 hrs prior to competition for amateur and professional athletes. This is

similar to the time period between the official weigh-in and competition of amateur wrestling, before the deaths of three collegiate wrestlers in 1997 (Oppliger et al., 2006). The wrestlers were attempting to rapidly lose 6.7%-10% of their body mass by using excess exercise, sweat suits and heated environments to meet their specific weight classes at the NCAA national championship tournament (CDC, 1998). The current regulations require collegiate wrestlers to weigh in 1 hr prior competition. The time period between the official weigh-in and competition is when athletes attempt to rehydrate and regain as much body weight as possible. Unlike wrestling, there are currently no guidelines or rules to minimize rapid weight loss and subsequent adverse health events in the sport of MMA fighting.

If MMA athletes are engaging in significant rapid weight loss prior to competition, coupled with a time period that is insufficient for complete rehydration, MMA athletes could be increasing their likelihood of an untoward health event both prior to and during competition. To our knowledge, this is the first study to evaluate the magnitude of dehydration and rapid weight loss in MMA fighters. Therefore, the purpose of the present investigation was to quantify the extent of dehydration, acute weight gain (defined as the amount of weight gained between the official weigh in and competition), and rehydration in MMA fighters prior to competition. It is hoped that results of this investigation will provide the impetus for body weight management guidelines for MMA fighters that promote safe participation and prevent unhealthy weight loss behaviors

CHAPTER 2

Methods and Procedures

Subjects

Forty male and female MMA fighters participated in this study. All fighters were required to pass a pre-fight physical to be eligible for this investigation. Data were collected during two separate MMA events in the states of North Carolina and South Carolina. During the 11-month period (Feb, 2010-Jan 2011) subjects gave their informed consent, and the study was approved by the Appalachian State University's Institutional Review Board for investigations involving human subjects. All subjects had a minimum of 1 yr MMA fighting experience. Confidentiality of the data were strictly maintained with respect to each subject.

Measurements

Acute Weight Gain: Official weigh-ins were held the day before the event. In two MMA events the official weigh-in was held 24 hrs prior to the fight. Actual body mass (kg) was obtained for all fighters including their fight shorts and was determined using a calibrated digital scale, i.e., official weight. The boxing commission personnel on site recorded all body weights. In North Carolina and South Carolina, the boxing commission regulates MMA competition.

Approximately 22 hrs after the official weigh-in, and ~ 2 hrs prior to the start of competition, fighters were re-weighed to determine body weight at the time of competition, i.e., fight weight. All re-weighing was done on the same scale that was used to determine the

official weight. Using the official weight and fight weight, the following variables were calculated (Scott, Horswill, & Dick, 1994):

$$\text{Acute Weight gain} = \text{Fight weight} - \text{Official weight}$$

$$\%\ \text{Weight gain} = (\text{Acute Weight gain} / \text{Official weight}) \times 100$$

Body Composition Assessment: Body composition was assessed according to skinfold analysis (SK) methods described in the NCAA Guidelines for Assessing Body Composition in Collegiate Wrestlers manual. SK measurements were taken once at the official weigh-in. SK measures were recorded with Lange SK calipers at three sites: triceps, subscapular, and abdomen. The SK calipers were calibrated to 10 $g \cdot mm^{-2}$ by the manufacturer. SK were measured three times in rotation at each site to the nearest 0.5 mm, with the mean value recorded. All SK measurements were taken on the right side of the body. The tricep SK was measured vertically in the midline of the posterior aspect of the upper arm, midway between the lateral acromion process of the scapula and the inferior margin of the olecranon process of the ulna. The subscapular SK was measured as a diagonal fold just below the inferior angle of the scapular on the right side of the body. The abdomen SK was raised vertically on the right side of abdomen 3 cm from the midpoint of the umbilicus. There was only one SK assessor, who was highly trained and experienced in measuring SK of wrestlers with a consistent test-retest reliability of $r > 0.90$. Body density ($D_{b)}$ was determined from the three SK measures using the prediction equation

$$D_b = [1.0982 - (\text{sum SK}) \times 0.000815] + [(\text{sum SK})^1 \times 0.00000084]$$

validated by Lohman (1981). Percent body fat (%BF) was determined from D_b using the Brozek equation (Brozek, Grande, Anderson, & Keys, 1963).

Hydration Status Assessment: Each fighter supplied a urine sample at each of the body weight assessments. The urine was placed in a plastic cup and the specific gravity (Usg) of the samples were determined by an optical refractometer (NSG Precision Cells Inc., Farmingdale, NY, USA). Once the urine samples were analyzed for Usg they were immediately discarded.

Statistical Analysis

Statistics were analyzed using SPSS software. Descriptive statistics were used to characterize the subjects. A paired *t*-test was performed to determine if there was a significant difference in body weight and Usg. Pearson product moment correlations coefficients were used to examine compare changes in body mass to Usg. Significance was set at a p value ≤ 0.05 for all variables.

CHAPTER 3

Results

Descriptive data for mean baseline subject characteristics are found in Table 1. Significant differences ($P < 0.01$) were found in body mass from the official weigh-in to 2 hrs prior to competition. Body mass increased by 3.4 ± 2.18 kg or 4.4% in the ~22 h period prior competition (Figure 1). A significant decrease was also found for Usg from the official weigh-in to 2 hrs. prior competition. Usg decreased from 1.028 ± .001 g/ml to 1.020 ± .001 g/ml (Figure 2). $P < 0.001$ for both variables.

Results further demonstrated that 39% of the subjects were significantly dehydrated (Usg > 1.021 g/ml), and of those subjects 11% were seriously dehydrated (Usg >1.030 g/ml) when assessed 2 hrs prior competition (Figure 3). It was also determined that only 23% of the subjects were classified as "well-hydrated" (Usg <1.010 g/ml) in the 2 hr. period prior competition. No significant correlations were found between the changes in body weight and changes in Usg throughout the investigation.

Table 1. Subject Characteristics (N=40)

Characteristics	Mean	Standard Error
Age	26	1
Height (m)	1.77	0.01
Mass (Kg)	75.8	1.5
Urine Specific Gravity (g/ml)	1.030	0.001
Fighting Experience (Years)	5	1
Skinfolds (mm)		
Abdominal	14.7	1.2
Triceps	10.7	0.8
Subscap	12.4	0.6
Skinfolds (% Fat)	13.4	0.5

Values are mean ± SE for n = 40. Baseline subject characteristics were taken at the official weigh-ins.

Y, years; m, meters; kg, kilograms; g/ml, grams per milliliter; mm, millimeter; % Fat, percent body fat

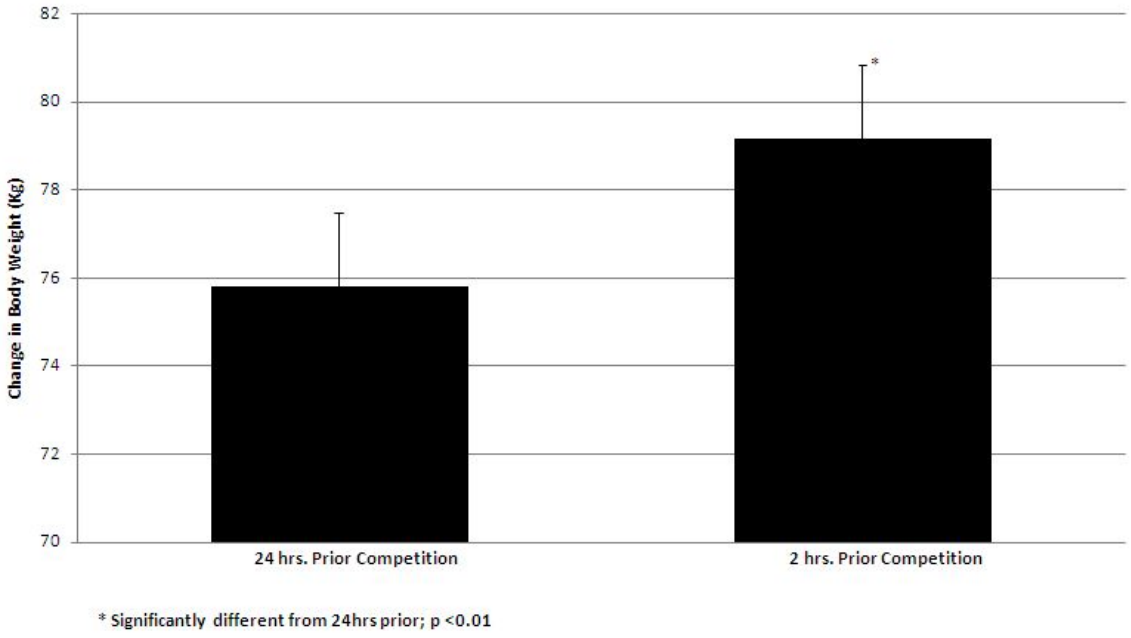

Figure 1. Changes in body weight 2 hr prior to competition.
Data are presented as mean ± SE

* Significantly different from the official weigh-in, $P < 0.001$.

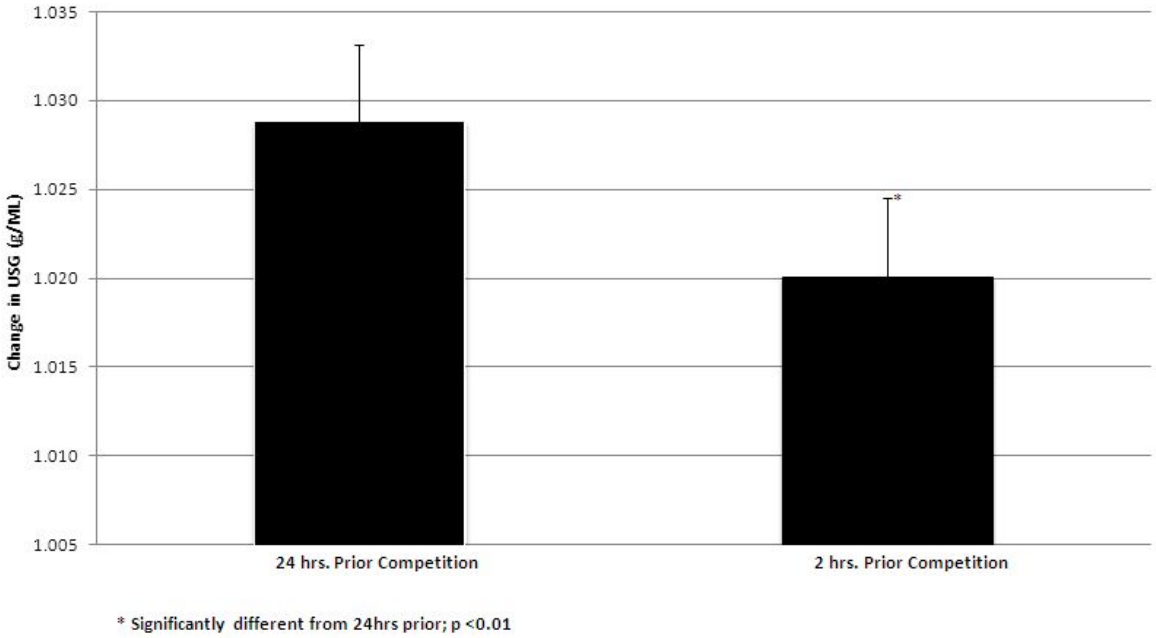

Figure 2. Changes in Urine Specific Gravity 2 h prior to competition.
Data are presented as mean ± SE

***** Significantly different from the official weigh-in, $P < 0.001$.

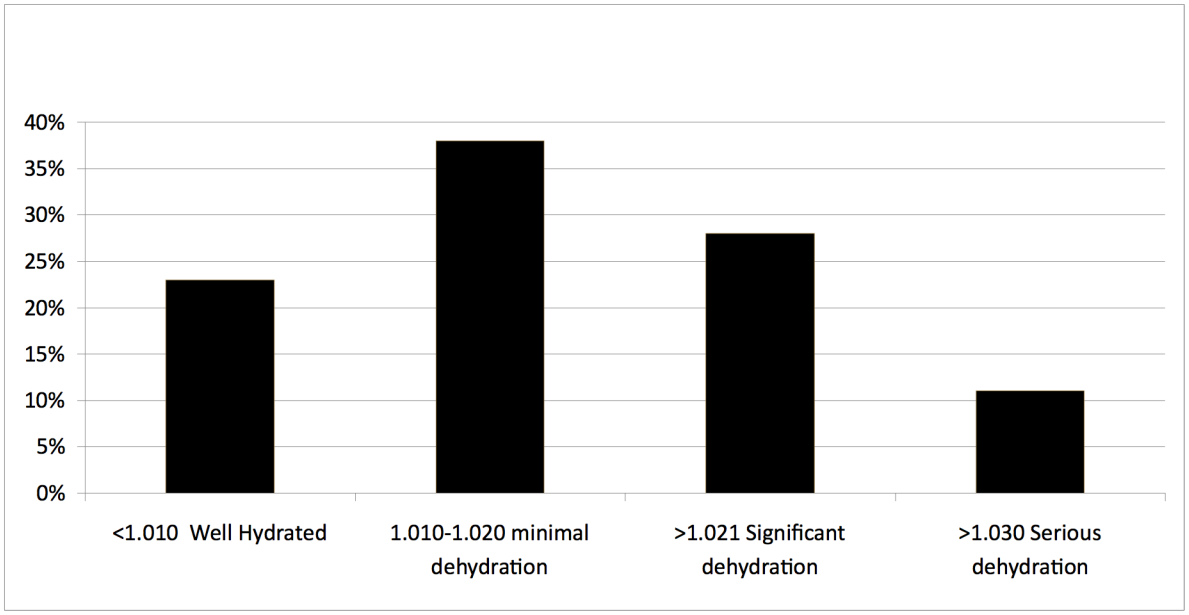

Figure 3. Hydration status immediately prior to competition. Usg measurements ~2 h prior MMA competition in N = 40. 39% of the subjects were significantly dehydrated (Usg > 1.021 g/ml), and of the subjects 11% were seriously dehydrated (Usg > 1.030 g/ml). It was determined that only 23% of subjects were classified as "well-hydrated" (Usg <1.010 g/ml).

CHAPTER 4

Discussion

To our knowledge, this is the first investigation to measure dehydration and rapid weight gain (RWG) of mixed martial arts (MMA) fighters prior to competition. The findings of our study are similar to previous investigations of amateur wrestlers. In our study, for the time period between the official weigh-in to just prior competition (~ 22h), RWG was 3.4 ± 2.18 kg or 4.4% body weight. The results of the present study are consistent with the findings of (Scott, et al., 1994) who measured the magnitude of RWG in collegiate wrestlers between the official weigh-in and competition (~ 20h) at the 1992 NCAA division I wrestling tournament. The results of that study found on average that RWG was 3.7 ± 1.3 kg or 4.9% of body weight. This is compared to the reported 0.9 ± 0.8 kg or 1.3 ± 1.2 % RWG found in 811 National Collegiate Athletic Association (NCAA) wrestlers during the NCAA national championship after the implementation of NCAA wrestling weight management plan (WMP) in 1998 (Oppliger, Utter, Scott, Dick & Klossner, 2006). Results of our current investigation are also in agreement with data reported in a later study by (Alderman, Landers, Carlson, & Scott, 2004). In their study RWG was measured in 2,638 high school (H.S.) Freestyle wrestlers. Results of that study found that H.S. wrestlers gained on average 3.4 kg, which represented 4.81% of body weight.

In the present investigation, hydration status was measured by means of urine specific gravity (Usg) and it was found that from the time period between the official weigh-in and just prior competition, Usg values significantly decreased from 1.028 ± 0.001 g/ml to 1.020 ±

0.001 g/ml. The NCAA has chosen a Usg measurement of ≤ 1.020 g/ml to identify a state of euhydration (Harms, 1992; Nordander et al., 2003; Zambraski, Foster, Gross & Tipton, 1976). Zambraski et al. (1976) measured changes in the urinary profiles of H.S. wrestlers prior to competition at the state H.S championships. In that study, the Usg values on average were 1.028 ± .0007 g/ml at the official weigh-in. Just prior to wrestling (~5 h after official weigh-in) Usg values on average were 1.026 ± .0005 g/ml indicating that the subjects were not in a euhydrated state just prior competition. These findings are similar to our study in which Usg values averaged 1.028 ± .001 g/ml at the official weigh-in with 39% of subjects recording a Usg value > 1.021 g/ml just prior competition, indicating they were not well hydrated.

Based on the significant RWG data following the official weigh-in in our current study combined with previous studies in wrestling that suggested RWG as a indicator of RWL, evidence suggests that MMA fighters are engaging in rapid weight loss (RWL) prior to the official weigh-in (Oppliger et al., 2006; Alderman et al., 2004). Previous investigators have measured the extent of RWL amounts in wrestlers prior to the official weigh-in. In a survey of high school wrestlers Lakin, Steen & Oppliger (1990) reported that, on average, 6.26% of body weight was lost to certify while Oppliger, Landry, Foster & Lambrecht (1993) revealed that average water loss was 5% of the subjects' body weight. Other investigations have measured RWL at competitive events including Ransone & Hughes (2004) who recorded the fluctuation in body weight of 78 collegiate wrestlers prior to competition. Results of that study demonstrated a significant difference existed in subjects' body weight 24 hours (73.93 kg) and 1 hour (72.53 kg) before a competitive match. Results of the present

investigation demonstrated that average RWG of subjects was 3.4 ± 2.18 kg and suggest that subjects engaged in RWL prior to the official weigh-in.

RWL is a concern for MMA fighters because it can ultimately lead to dehydration related health issues and impaired performance. Results of the present study, demonstrated that 39% of the subjects were significantly dehydrated (Usg >1.021), and of those subjects 11% were seriously dehydrated (Usg > 1.030) when assessed 2hrs prior competition. One subject in the present study demonstrated a RWG of 9.81 kg or 10% of his BW in ~22 h period prior competition. This value is consistent with the 6.7%-10% of RWL demonstrated by the collegiate wrestlers in 1997, which resulted in heat-related deaths. Dehydration, or excess body water loss has negative physiological consequences that impair performance. Dehydration of just 1% of body weight can decrease performance (Armstrong et al., 2007) and has been shown to decrease performance of collegiate wrestlers (Webster, Rutt, & Weltman, 1990).

Bounty et al. (2011) describe a MMA fight as three, 5-minute rounds with a 1-minute break between rounds. Bounty et al. (2011) further explain that a MMA fight is made up of many relatively high-intensity anaerobic episodes intermixed with several lower intensity paced periods that can be thought of as mini active recovery phases. Therefore, it is beneficial to extract information on dehydration and its effect on anaerobic performance. Maxwell, Gardner & Nimmo (1999) reported a 3.9% reduction in the ability to perform intermittent anaerobic running after a body weight reduction of ~2.0% induced by exercise and heat induced dehydration. A study by Webster et al. (1990) investigated the effects of a 4.9% rapid weight loss in collegiate wrestlers during the last 12 hrs prior to weigh-ins. The results demonstrated a significant 21.5% reduction in anaerobic power and 9.7% reduction in

anaerobic capacity during a 40 s Wingate test. Montain et al. (1998) showed a 15% reduction in quadriceps endurance in response to 4% dehydration. Saltin (1964) reported that time to fatigue at 100% VO_{2max} was reduced by ~16% following thermal dehydration by 2.78% body weight. Taken as a whole these studies demonstrate that acute dehydration has substantial effects on the ability to maintain a high-intensity output as measured by muscular endurance in exercise that derives energy from anaerobic sources. Results of our study found that 39% of MMA fighters were significantly dehydrated, as assessed by Usg just prior competition. By extension this acute dehydration may have promoted sub-optimal performance during competition in a significant proportion of our subjects.

In addition to performance decrements extreme dehydration is detrimental to health, as the body becomes incapable of cooling its core body temperature (Cheuvront et al., 2003). The CDC investigation into the deaths of three collegiate wrestlers revealed that in attempt to make their desired weight classes, rapid weight loss methods were utilized and weight loss attempts ranged from 6.7-10% (CDC, 1998). The combination of weight loss methods (i.e., extreme environment, excessive exercise) significantly increased dehydration and led to increased core body temperature and heat related deaths of the three wrestlers. In the CDC (1998) report it was demonstrated that symptoms shown before illness were extreme fatigue, unsteady legs, unable to communicate, and breathing difficulty. An evaluation of the wrestlers post mortem found that rapid weight loss adversely affected cardiovascular function, electrolyte balance, thermal regulation, and renal function all leading to death. Similarities occurred in a case-study involving another young amateur wrestler that did not result in death (Myers, Guskiewicz, & Riemann, 1999). A young wrestler (age 20) used a combination of rapid weight loss methods, including consumption of diet pills containing

ephedrine and increased exercise in an attempt to intentionally dehydrate 4.5-7 kg for the purpose of making a weight class requirement. The results of the case study reported that even though the subject survived he did experience chest pain, tachycardia, hyperventilation and eventual loss of consciousness. While there has yet to be an adverse health event secondary to dehydration in the MMA community, results of the present study suggest that the possibility of such an untoward event exists.

A multitude of research on rapid weight loss followed the sudden death of the three wrestlers. Choma, Sforzo, & Keller (1998) found that rapid weight loss causes physiological effects that were accompanied by transient mood reduction and impairment of short-term memory. In a study by Karila et al. (2008) eight elite wrestlers were studied before and after 2-3 week weight reduction regimen with a resulting mean body weight loss of 8.2% ± 2.3%. It was reported that increased fatigue, tension, and anger, reduced vigor, and a lack of sleep were symptoms associated with the engagement of RWL by the subjects. Overall, previous research on the physiological responses of dehydration after the deaths of the three collegiate wrestlers have concluded that rapid weight loss impairs overall health and is not recommended. This is reinforced by the ACSM's position statement on weight loss in wresters (Oppliger, Case, Horswill, Landry, & Shelter, 1996)

While there are currently no published reports on a dehydration health-related event before, during or after an MMA event due to RWL, the previous tragedies in collegiate wrestling coupled with the results of the present study warrant regulation of RWL practices in MMA athletes. MMA is a unique sport that does not have a specified "season" and lacks a national governing body such as the National College Athletic Association (NCAA). Competition rules and official weigh-in procedures vary state to state, within the USA and as

such it is difficult to make overarching weight management recommendations for MMA from a national perspective. However, weight management recommendations from ACSM (Oppliger, et al., 1996) and similar weight-classified sports can provide possible regulatory changes that could be implemented within the MMA community.

ACSM's 1996 position stand on RWL in wrestlers recommends discouraging the use of extreme environments for making weight while also urging wrestling to adopt new state or national governing body legislation, i.e., NCAA. The ACSM position stand states that the governing body should schedule weigh-ins immediately prior to competition, add additional weight classes, and have cooperative efforts between coaches, exercise scientists, physicians, dietitians, and athletes to systematically collect data on body composition, hydration state, energy and nutritional demands, growth, maturation, and psychological development of wrestlers.

After the death of three collegiate wrestlers in 1997-1998, the NCAA implemented weight management rules including: moving weigh-ins closer to competition, establishing a minimal wrestling weight, body composition/hydration assessment, and prohibiting extreme rapid weight loss methods. The new regulations were later investigated for their effectiveness and were shown to be successful in minimizing unhealthy weight loss of collegiate wrestlers (Oppliger, et al., 2006). The sport of Judo, a martial art integrated into MMA, has demonstrated RWL practices by its competitors to make official weight by examining the results of a RWL survey completed by 822 judo competitors (Artioli, Gualano, et al., 2010). Using the experience and research from the sport of wrestling and combining it with the current practices of Judo competitors, weight management regulations have been proposed (Artioli, Franchini, et al., 2010). These include that the competition begins no more than 1 hr

after the weigh-in, each athlete is allowed to only weigh-in one time at the weigh-in, rapid weight loss methods are prohibited in the day of competition, and athletes must pass a hydration test to get the weigh-in validated.

As previously mentioned, a feasible medical concern of rapid weight loss is the possibility of fighters competing in a significantly dehydrated state. The effects of dehydration are similar to those seen in concussed individuals. Symptoms include: imbalance, feeling slowed down, fatigue and headache (Patel et al., 2007) and in the sport of wrestling RWL has been reported to cause physiological effects that are accompanied by transient mood reduction and impairment of short-term memory (Choma et al., 1998). In a combative sport such as MMA, symptoms of dehydration may result in performance decrements and place the fighter at greater risk of taking traumatic strikes to the head when compared to fighting in a euhydrated state. At the pre-fight physical may be valuable in assessing the fighter's "fitness" to compete. Therefore, a possible regulation change in MMA could be to include administration of a concussion-like symptom test at the pre-fight physical prior to competition. Two common tests that exists are the Sport Concussion Assessment Tool Version-2 (SCAT-2) and the Sports Concussion Office Assessment Tool (Patricios, Collins, Branfield, Roberts, & Kohler, 2012). Common tasks of these tests include concentration, immediate memory and balance. Inclusion of a baseline concussion test would allow for easy interpretation of a possible concussion secondary to excess force to the head that may be exacerbated with significant dehydration.

Another characteristic to take into consideration is the experience level of MMA fighters. Fighters in our study on average had 4.8 ± 3.8 yrs of fighting experience. Compared to collegiate wrestlers who have been participating in RWL and weight-management

practices for most of their competitive life, MMA fighters are relatively inexperienced in weight-management practices. As a result, MMA athletes and coaches should undergo formal education in determining safe competitive weights through body composition assessment. Establishment of a minimal competitive weight based on body composition assessment will allow for body weights that will meet sport and physical activity requirements while also allowing the athletes to meet their energy and nutritional needs for optimal health and performance. In a recent case study, a undisclosed world champion professional boxer is was reported that his typical approach to "making weight" included no consumption of food or drink for 1-2 days preceding weigh-in coupled with the use of sweat suits and low-intensity exercise in the hour preceding the weigh-in. During the case study, a new intervention was introduced and the boxer went on a 12-week diet and training protocol in which he lost 0.9 +/- 0.4 kg/wk equating to 9.4 kg and a 5.1% loss in body fat. At the official weigh-in, the athlete successfully weighed-in without performing RWL techniques for the first time in his career (Morton, Robertson, Sutton, & MacLaren, 2010). It is hoped that if MMA athletes and coaches are educated on such protocols and recommendations of the ACSM that the unhealthy RWL practices found in MMA will decline.

Overall, it is evident from results of the present investigation that MMA fighters undergo a significant amount of RWG from the official weigh-in to just prior competition. 39% of fighters recorded a Usg value above 1.021 g/ml, indicating a dehydrated state. It has been reported that dehydration inhibits performance and results in health risks that can potentially lead to untoward health events. The sport of wrestling has previously faced tragedy that threatened its existence. The rule changes implemented by the NCAA and the National Federation of State High School athletic associations have assisted in preventing

additional health-related incidents in the sport of wrestling. Other martial arts such as Judo have similar weight management issues as of those that were revealed in the present study. Therefore, based on the results of the present investigation weight-management regulations for MMA competitors are warranted to aid in preventing adverse health events that have previously been documented in the sport of wrestling.

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VITA

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