The Use of Hydration Status to Monitor How Division II Collegiate Wrestlers Achieve Lowest Allowable Weight Class

By

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THE USE OF HYDRATION STATUS TO MONITOR HOW DIVISION II COLLEGIATE WRESTLERS ACHIEVE LOWEST ALLOWABLE WEIGHT CLASS

In partial fulfillment of the requirements for the degree,

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Abstract

Voss, A. (2015). *The Use of Hydration Status to Monitor How Division II Collegiate Wrestlers Achieve Lowest Allowable Weight Class.* This study evaluated hydration status, lean mass and fat mass loss, and any participation in rapid weight loss over the course of one competitive DII collegiate wrestling season. A total of 10 male participants aged 19-23 years volunteered for this study. All participants competed in varsity matches for a Division II collegiate wrestling team. The ten participants all completed the weight class certifications following the NCAA protocol on 10/22/14. The protocol requires wrestlers to be hydrated with a urine specific gravity of 1.020 sp. gr. or less prior to being officially weighed or measuring body composition. Nine of those wrestlers competed in a wrestling dual at the second data collection on 1/9/15, while only five competed in the wrestling dual on the final collection date on 2/13/15. On average, the wrestlers (n=9) lost 3.89 ± 2.34 pounds of fat mass and 3.11 ± 3.31 pounds of lean mass over the 12-week period from the initial certification date to the 2nd test date. Additionally, on average the wrestlers (n=5) lost 3.69 ± 2.80 pounds of fat mass and 2.30 ± 5.25 pounds of lean mass over the 17-week period from initial certification to the final test date. A related-samples McNemer test was conducted to determine significance from the expected hydration status and the actual hydration status of the wrestlers. Eighty-nine percent of wrestlers (n=9) had a urine specific gravity above 1.020 sp. gr. at the time of official weigh-ins for the 2nd hydration test date; 100% of the wrestlers (n=5) had a urine specific gravity above 1.020 sp. gr. at the time of the final test date. A urine specific gravity above 1.020 sp.gr. indicates the wrestler is in a dehydrated state according to NCAA standards. No significant findings were reported for weekly weight loss as the wrestlers used official weigh-ins when recording weight. The wrestlers did not record a weight 24-48 hours prior to the official weigh-ins, so rapid weight loss could not

be observed. The findings of this study suggest that even though individual weight loss over the course of a wrestling season is better controlled, wrestlers are dehydrated just an hour prior to competition, and also are losing a combination of fat mass and lean mass. A wrestler's performance may be negatively affected as a result of dehydration and lean mass loss. Additionally, dehydration may increase the wrestler's chance of experiencing exertional heat illnesses.

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Chapter 1

Introduction

Wrestling is a sport known for significant weight loss by the athlete, with the goal to gain a competitive edge over the opponent (Oppliger, Magnes, Popowski, & Gisolfi, 2005). Several days prior to competition, it is not uncommon for wrestlers to lose excessive amounts of weight in order to "make weight." Making weight refers to athletes dropping to a weight that is less than or equal to the desired weight class. For example, for a wrestler wishing to wrestle at the 125 pound weight class, he must weigh in (1 hour prior to competition) at 125 pounds or less to compete in that specific weight class; if they weigh in greater than 125 pounds they may choose not to wrestle or may choose to wrestle at the next weight class of 133 pounds. Techniques or strategies used for weight loss include: sweat suits made of rubber, saunas, caloric restrictions and extreme exercise sessions in hot, humid environments (Davis, Dwyer, Reed, Bopp, Stosic & Shepanski, 2002). These measures are known to cause severe dehydration prior to competition (Utter, 2001).

Dehydration due to fluid loss is not the only contributor to rapid weight loss or restrictions to lose weight. Nutritional deficits also occur; simply because the athlete is trying to maintain or lose weight, the athlete will choose not to eat or eat very little (Ransone & Hughes, 2004). Decreasing caloric intake can also contribute to dehydration because the body absorbs water from food (Wildman & Miller, 2004). Athletes whose sport requires weight classes or even small physiques, like gymnasts, will restrict caloric intake to accomplish the weight goals and aesthetic appearance (Fletcher, Dawes & Spano, 2014). Rapid weight loss typically is a result of water loss and a decrease in the athlete's caloric intake (Artioli, Franchini, Nicastro, Sterkowicz,

Solis, & Lancha, 2010). The rapid weight loss can result in dehydration, depleted glycogen stores and a reduction in lean muscle mass, as opposed to a reduction in fat mass (Koral & Dosseville, 2009). The lean mass loss occurs from muscle fibers, specifically muscle protein, breaking down to be converted to glucose for energy (Powers & Howley, 2012). The breakdown of muscle protein for glucose especially occurs in the case of restricted diets; that potentially causes a decrease in muscle strength and performance (Koral & Dosseville, 2009). Even a gradual loss in body mass from a long period of dietary restriction has been suggested to affect protein breakdown, increasing catabolism of muscle protein to provide the needed energy in place of glycogen stores that are not maintained from the restricted diet (Wildman & Miller, 2004). The loss in lean mass would affect longer bouts of exercise in wrestlers (Koral & Dosseville, 2009).

Evaporation during exercise is the primary mechanism of heat loss (Powers & Howley, 2012). The function of sweat evaporating off the skin is to regulate core temperature; without sweat and evaporation, the athletes' core temperature could rise rapidly (Casa, 2000). Sweating causes loss of body fluids, and if the fluid intake is less than the evaporation, dehydration will occur (Powers & Howley, 2012). Inadequate fluid intake prior to and during exercise could predispose athletes to dehydration, resulting in possible heat related illness and shut down of important physiological body functions (Powers & Howley, 2012). Dehydration can occur in any athletic setting; coaches and athletes need to be aware of the conditions and develop schedules to avoid voluntary dehydration. Athletes should begin an event in a hydrated state and replenish fluids during exercise sessions; ideally fluid intake should equal sweat loss (Casa, 2000).

Wrestlers of all levels, youth to collegiate, typically participate in rapid weight loss routines in order to gain a competitive edge over a smaller opponent, and to meet the pressures put on them to do well by coaches, parents and peers. The wrestler drops to a lower weight class,

theoretically only losing body fat, while maintaining strength, thus being stronger than the smaller opponent (C. Pipher, personal communication, October 8, 2014). In the researcher's experience, the majority of coaches do not care how the athletes make weight, but nonetheless expect the wrestler to achieve the desired weight class. Following the death of three wrestlers in 1997, with the cause of death being hyperthermia caused by dehydration following the participation in rapid weight loss techniques (Artioli, Franchini, Nicastro, Sterkowicz, Solis, & Lancha, 2010), several athletic governing agencies have changed the policies and procedures required of a wrestler to compete.

The National Collegiate Athletic Association (NCAA) released a change in policy that governs the amount of weight that can be lost in a period of time, as well as being certified in a hydrated state (Utter, 2001). In order to become certified, the wrestler must pass a hydration test; then weight and body composition measurements can be collected (Martin, 2011). Hydration status is determined using urine specific gravity (USG) as the standard measurement and for a wrestler to be considered hydrated the USG must be 1.020 sp. gr. or less (Martin, 2011). USG is the ratio of solutes to water in the urine (Armstrong, Herrera-Soto, Hacker, Casa, Kavouras, & Maresh, 1998). Another aspect of this policy is the wrestler may not lose more than 1.5% body weight per week following the certification day (Martin, 2011). The program provides a weight loss plan throughout the season and official weigh-ins at NCAA duals meets and tournaments (all scheduled meets and tournaments on the team's schedule are reported to the NCAA as official weigh-ins) are used to monitor the weight loss (Martin, 2011). For example, if an athlete's weight loss plan allows the athlete to lose five pounds by the team's first competition, at the competition's official weigh in, the athlete can only be five pounds lighter compared to the

weight on the initial certification day. The data and monitoring of weight does not occur weekly, rather only at the time of official weigh-ins for a dual meet or tournament (Davis et al., 2002).

The National Athletic Training Association (NATA) also released a position statement, not just specific to wrestling but an overall statement for athletes, and it contains sport specific requirements in order to prevent dehydration and heat related illness (Casa, 2000). Although these policies have been put in place to protect the athletes, they are still engaging in unsafe and unhealthy weight loss practices (Davis et al., 2002).

Researchers have shown that in unannounced weigh-ins of wrestlers, weeks after a minimal weigh-in test, athletes had regained 3-18 pounds (Bartok, Schoeller, Sullivan, Clark, & Landry, 2004). Bartok et al. (2004) investigated wrestlers using minimal weigh in tests without hydration testing; all wrestlers were weighed on a digital scale. Based on weight alone, the wrestlers were given a minimal weight that they could compete at, as opposed to weight, hydration and body composition measurements used to determine lowest allowable weight (Bartok et al., 2004). Wrestlers would typically weigh in in a dehydrated state to insure a lower weight class could be obtained (Bartok et al., 2004). When the unannounced weigh in was done, significant findings of weight gain were present (Bartok et al., 2004). The NCAA implemented hydration testing to be a part of minimal weight testing to minimize unhealthy weight loss in collegiate wrestlers (Ransone and Hughes, 2004). The program was also implemented to reduce the time interval between weigh-ins and competition (Artioli et al., 2010). In years past, the weigh in time was not as close to actual competition, ranging from 3-6 hours prior to a dual meet or in the case of tournaments, longer times frames of up to 12 hours were allowed (Artioli et al., 2010). The longer time frames allowed athletes to regain some weight prior to wrestling, giving

the athlete a competitive edge over the smaller athlete (Artioli et al., 2010). The time allowed to regain was sufficient time for several physiological variables to return to baseline, including high intensity anaerobic metabolic pathways; hence resulting in a potential performance boost (Artioli et al., 2010). The new rules promote weight class equality, meaning that the wrestlers would be competing against opponents with similar weights (Artioli et al., 2010). The official weigh in is generally one hour prior to competition and a minimal weight class is established on the certification date at the beginning of the season, to ensure the wrestlers maintain a healthy weight throughout the season (NCAA, 2011).

Statement of the problem

Wrestlers continually subject themselves to unhealthy weight loss techniques in order to gain a competitive edge or simply to achieve the desired weight class (Oppliger, et al., 2005). There is great risk involved in rapid weight loss routines, specifically dehydration, and can have many adverse effects on wrestlers including heat illness, cardiovascular risk and even death (Popkin, D'Anci, & Rosenberg, 2010). Following the three deaths of wrestlers in 1997, the NCAA and other governing bodies, such as the NATA, took action to create safer weight loss routines and promote competitive equality among the athletes. Although improvements have been made, wrestlers still engage in rapid weight loss immediately prior to competition putting them at risk of dehydration and other physiological function compromises (Oppliger et al., 2005). Unfortunately, these techniques are a part of the wrestling culture and have been for many years (Oppliger et al., 2005). Education and research is needed to inform coaches, athletes and the leaders in the sport of the dangers of rapid weight loss and dehydration.

Purpose of the study

The purpose of this study was to observe the weight loss patterns in collegiate wrestlers throughout the Division II collegiate wrestling season. Specifically, this study looked for extreme weight loss 24-48 hours prior to a competition. Official weigh-ins were compared to the wrestlers' weights 24-48 hours prior to competition. If wrestlers participated in multiple dual meets or a multiple day tournament in one week, the official weight of the first dual meet or official weight of the first day of the tournament was used. Additionally, at the time of official weigh-ins, urine specific gravity was measured to determine if the wrestlers were in a hydrated state prior to competition. Body composition was also measured at each hydration test date to determine any lean mass loss and/or fat mass loss. Furthermore, the purpose of this study was to gather information to educate athletes and coaches on the dangers of rapid weight loss, and possibly refer them to professionals in order to lose the weight in a healthy manner.

Hypotheses

H1: It was hypothesized that even though a weekly weight descent timeline is in place following the NCAA certification, wrestlers would still participate in rapid weight loss techniques 24-48 hours prior to competition.

H2: It was hypothesized that the wrestler's weight loss would not coincide with the urine specific gravity measurement at the beginning of the season, indicating that the wrestlers were dehydrated at weigh-ins.

H3: It was hypothesized that monitoring wrestler's weight loss using skin fold measurements would show that wrestlers were not only losing fat mass and fluids but also lean mass while participating in rapid weight loss techniques.

Research Questions

RQ1: Do wrestlers participate in rapid weight loss 24-48 hours prior to competition rather than losing the weight gradually throughout the season? Additionally, once the wrestlers reach the lowest allowable weight, do they maintain a reasonable weight range week to week so they don't participate in rapid weight loss?

RQ2: Were wrestlers hydrated at weigh-ins for an NCAA wrestling competition, as determined by a urine specific gravity of 1.020 sp. gr. or lower?

RQ3: Were wrestlers losing lean mass and water in addition to fat mass when participating in rapid weight loss techniques?

Delimitations

D1: Only one division II collegiate wrestling team was used, specifically ten wrestlers at the initial certification on 10/22/14, nine at the second date on 1/09/15, and five at the final test date on 2/13/15.

D2: A Detecto- 439 physician scale was used for all weigh-ins to adhere to the wrestling team's normal routine. The same scale was used throughout the research and data was recorded to the nearest tenth of a pound to remain consistent with the NCAA guidelines (Martin, 2011).

D3: The researcher used skin fold calipers to measure skin folds and calculate body composition. Skin fold measurements are required by the NCAA during the Weight Certification program, and

to remain consistent the researcher repeated these measurements for the study. The NCAA requires only three site measurements, but the researcher administered the seven site protocol for increased accuracy (Jackson & Pollock, 1985).

D4: The researcher used a refractometer to determine the wrestler's hydration status, measuring urine specific gravity to adhere with the requirements of the NCAA weight certification program and for consistent results with the initial weight certification.

Limitations

L1: A limitation of this study was not all weight classes have to lose such a significant amount of weight. Some wrestlers may wrestle at a weight class that doesn't require them to lose much weight if any at all; for example a heavy weight.

L2: A limitation to this study was the requirements by the NCAA for the weight certification program. The program requires the assessor (researcher) to use a refractometer to determine hydration, a digital scale for weight and skinfold measurements for body composition. The researcher used the same instrumentation due to alternate techniques potentially yielding different results.

L3: A limitation to this study was the number of wrestlers measured did not stay the same throughout the study. All of the wrestlers tested at the initial certification date potentially would not wrestle during the season, and would not participate all in varsity duals or tournaments.

Assumptions

It was assumed that the population chosen for this study would show a strong representation of all Division II collegiate wrestlers. It can also be assumed that due to the

unannounced last two hydration test dates, the athletes would not change their normal routine in order to alter the results.

Definition of Terms

Body Composition: The proportion of fat and fat-free mass in the body referred to as a two component system. Skin fold measurements were used in this study to determine body composition or the athlete's percent body fat.

Dehydration: Sweat loss exceeding fluid intake, that results in a percentage of total body weight lost.

Minimal Weight Testing: a program that uses hydration (urine specific gravity), weight (digital scale), and body composition (skin folds) to determine a weight that is healthy and safe for a wrestler to descend to (Utter, 2001).

Rapid Weight loss: The American College of Sports Medicine defines rapid weight loss as an average per week of 4-5 pounds lost and may exceed 6-7 pounds.

Refractometer: The refractometer was used to measure hydration status, via urine specific gravity.

Urine Specific Gravity: a standard measure of the concentration of ions in a substance. The number for USG represents the ratio of the density of urine to the density of water (Armstrong et al., 1998).

Chapter 2

Review of Literature

In the early part of the 1997 wrestling season, three wrestlers died due to participating in acute dehydration techniques to make weight (Oppliger et al., 2005). Because of these deaths, the NCAA revised the policies and procedures in place to establish a permanent healthy weight class and eliminate tools that accomplish rapid weight loss (Buford, Rossi, Smith, O'Brien & Pickering, 2006). The NCAA made changes to protect the athlete. Coaches, athletes, physicians and athletic trainers are all educated on the topic and required to watch the annual NCAA wrestling rules presentation (Martin, 2011). The coach and assessor are required then to enter dates: the first day of school and first practice, the team schedule and a full team roster (Martin, 2011). This data will be stored, then after official weigh-ins, hydration testing and skin fold measurements are completed (Martin, 2011). These measurements are then entered and accepted by the coach and cannot be altered (Martin, 2011). A minimal weight will be calculated and the athlete can descend to this weight class at no more than 1.5% of their body weight per week and may not officially weigh in more than one weight class above their minimal weight (Martin, 2011). If the athlete does weigh in more than one weight class above their minimal, they forfeit the ability to wrestle at that class for the season (Martin, 2011).

Since the implementation of this program in 1998, extreme weight loss has been somewhat controlled (Buford et al., 2006). The re-weighing of the athletes however, is not done in a state of hydration (Buford et al., 2006). Researchers have shown that competing in a dehydrated state can reduce muscle function and promote fatigue (Judelson, Maresh, Anderson, Armstrong, Casa, Kraemer &Volek, 2007). The increase in core temperature past a certain threshold is the cause of these physiological findings (Judelson et al., 2007). In the past,

wrestlers lost an average of 10-15% of their body mass; the program in place now only allows for a maximum of 5% loss of the wrestler's body weight in a hydrated state (Utter, 2001).

In addition to the NCAA's policies, the National Athletic Trainer Association (NATA) released a position statement to protect all athletes from dehydration during sport (Casa, 2000). The position statement included making sport specific hydration protocols, beginning each exercise well hydrated; fluid replacement during exercise should match fluid loss, and understanding how climate plays a role in becoming dehydrated (Casa, 2000). The NATA initially recommended that a hydration protocol is established that includes the following: considers athlete's sweat rate; sport dynamics, such as accessibility to fluids; environment the athlete is participating in; how long the athlete has been acclimatizing to the environment; and exercise duration and intensity (Casa, 2000). The position statement coincides with policies like the NCAA weight management program, but is mainly to educate athletes, coaches and medical staff on the well-being of athletes (Casa, 2000). Physicians and athletic trainers should be competent in recognizing the detrimental effects of dehydrated athletes (Casa, 2000). Advocating proper hydration, nutrition and weight loss or gain for the athletes should be a priority of the medical staff for the health and best interest of the athlete (Casa, 2000).

Physiological Changes due to Rapid Weight Loss

During exercise, the primary mechanism for heat loss is evaporation of sweat from the skin (Powers & Howley 2012). Losing heat during exercise, especially during endurance activities, is extremely important to maintain proper physiological function of the body (Powers & Howley 2012). Wrestling is a combination of anaerobic metabolism, short quick bouts of intense exercise, and aerobic metabolism, longer bouts requiring oxygen (Grindstaff & Potach, 2006). The aerobic aspect of wrestling is an endurance activity that will result in sweating, and

the nature of wrestling can inhibit proper evaporation (Grindstaff & Potach, 2006). Wrestling practice is conducted in a warm/ hot environment and athletes are potentially dehydrated prior to participation in practice or competition due to the previously mentioned weight loss practices (Buford et al., 2006). Sweating and evaporation regulates the body's core temperature; a result of released energy that is absorbed from the body, which evaporates off the skin and decreases the temperature of the superficial blood vessels (Powers & Howley, 2012). The cooled venous blood returns to the core and counteracts the rise in temperature from exercise (Tortora, 2011). In order to ensure that the body has adequate fluids for sweating and evaporation to take place, the body must be maintained in a homeostatic hydrated state (Powers & Howley, 2012). Dehydration is defined as sweat loss exceeding fluid intake (Tortora, 2011).

Dehydration reduces total plasma volume as the result of vital fluid loss (Powers & Howley, 2012). Common side effects of dehydration include: increased heart rate, decreased maximum cardiac output, reduced muscle function and promotes fatigue in the athlete (Judelson et al., 2007). If an athlete becomes dehydrated more than 3% of their body weight, the body's physiological functions are compromised, exercise performance is hindered and the athlete is at greater risk to experience exertional heat illnesses (EHI) (Casa, 2000). EHI's can manifest as muscle cramping, heat exhaustion and heat stroke (Casa, 2000). The onset of EHI varies and can become apparent during activity (Casa, 2000). Additionally, if an athlete begins a physical activity in a dehydrated state, heat illness could result more rapidly (Casa, 2000).

Studies have been conducted to investigate the effects of dehydration on muscle function, muscle strength and muscle power (Buford et al., 2006). The physiological effects of fluid loss may result in detrimental effects to the cardiovascular system, which then may result in changes to the musculoskeletal system (Casa, 2000). These finding have not been proven to have any

relation to decreased muscle strength or power (Judelson et al., 2007). However it has been demonstrated that these variables (strength and power) are briefly independent of the cardiovascular system, and rely mainly on stored adenosine triphosphate (ATP) and creatine phosphate (CP); thus the aerobic aspect of wrestling may be impacted by the fluid loss and a decrease in plasma volume (Judelson et al., 2007). The decrease in plasma volume due to fluid loss can inhibit nutrient delivery to recovering muscles (Powers & Howley, 2012). Examples of cardiac functions affected are a decrease in plasma volume due to fluid loss, decrease in nutrients, including oxygen delivery to the muscles, and an alteration in cellular metabolism in the muscle (Casa, 2000). The increase in viscosity of the blood also can decrease the cardiac output and as a response to that, increase the work load of the heart (Powers & Howley, 2012). However, McDermott, Casa, Lee, Yamamoto, Beasley, Emmanuel, & Maresh (2013) state that for athletes that are in a dehydrated state following a competition, and do not replenish fluids, the efficiency of recovery will be hindered (i.e., increased recovery time). Ultimately, severe dehydration can result in the shut-down of major body functions, but even minor dehydration can have huge detrimental effects on the body (Casa, 2000).

Losing lean mass as opposed to fat mass is also a factor in affecting performance (Koral & Dosseville, 2009). In the past, prior to the NCAA rule changes, wrestlers would weigh in only using weight (Judelson et al., 2007). There were no body composition concerns and no limitations on how much weight they could potentially lose to make weight. Rapid weight loss results in loss of fluids but also lean body mass (Garthe, Raastadm, & Sundgot-Borgen, 2011). Garthe et al. (2011) recruited thirty-six athletes to follow a 4- to 12-week weight loss intervention based on randomly allocated groups, combining diet restriction and strength training. Data was collected four times: baseline, post-intervention, 6 months post-intervention

and 12 months post-intervention (Garthe et al., 2011). The weight loss intervention included individualized diet programs as well as strength training protocols set by an exercise physiologist (Garthe et al., 2011). The length of the intervention was determined by the rate of weight loss, slow rate or fast rate, and the desired weight loss of each athlete (Garthe et al., 2011). The weight goal of each athlete was set by an exercise physiologist, and the final weight was based on body composition measurements to calculate the minimum fat percentage each athlete could potentially lose (Garthe et al., 2011). For example, if a 154-pound athlete was set to lose 11 pounds, as determined by the exercise physiologist, the athlete would either lose 1.4% of body fat per week over a 5-week period (fast rate) or 0.7% of body fat per week over a 10-week period (slow rate) depending on which group the athlete was randomly allocated to (Garthe et al., 2011). The study reported that fat mass decreased 5.8% in slow rate weight loss intervention compared to 5.7% fat mass loss in fast rate weight loss interventions (Garthe et al., 2011). The researchers also reported no significant changes in lean body mass for the fast rate group post intervention, however lean body mass increased significantly in the slow rate group following the strength and weight loss program (Garthe et al., 2011). The significant lean body mass increase was observed post intervention, however lean body mass returned to base line 6 months post-intervention (Garthe et al., 2011). Losing weight rapidly to make weight as wrestlers do, may cause a loss in lean body mass, potentially not giving them the competitive edge over the smaller opponent, due to a loss in strength (Oppliger, 2005).

Wrestling as a Sport

As previously mentioned, rapid weight loss can have very adverse physiological effects on the body (Casa, 2000). Even though wrestling involves short, high power and strength bouts, mostly utilizing anaerobic metabolic systems, matches can last ten or more minutes and practices

can last at least two hours, thereby utilizing aerobic metabolic systems (Judelson et al., 2007). Training therefore should incorporate methods to improve all metabolic systems and that is to include nutritional requirements as well (Judelson et al., 2007). Wrestlers typically lose weight in a rapid fashion, and significant weight loss usually occurs a day or two before competition (Oppliger, Utter, Scott, Dick & Klossner, 2006). Artioli et al. (2010) reported that approximately 80% of wrestling competitors engage in weight loss procedures. The techniques used to lose the weight start with the conditions the wrestlers practice in such as warm, humid environments and excess clothing (Goutlet, 2012). The wrestling room is typically a small room and kept at higher temperatures, around 80 degrees Fahrenheit, and the room also becomes more humid as the practice continues. Wrestling in hot, humid environments can increase sweat loss leading to dehydration (Goutlet, 2012). The athletes may choose additional clothing; for example it is not uncommon for wrestlers to practice in sweat suits, hoods, or tights to increase the body's temperature in order to sweat more (Goutlet, 2012). In addition, wrestlers decrease their caloric and fluid intake, especially 24-48 hours before competition weigh-ins (Roemmich & Sinning, 1997). The time period of 24-48 hours prior to the competition is noted as extreme caloric restriction for wrestlers; however, Roemmich (1997) found that on no day of the week during the season did the wrestlers consume enough calories or fluids to meet the demands of the sport. Additionally, Weber, Mihalik, Register-Mihalik, Mays, Prentice & Guskiewicz (2013) noted that collegiate wrestlers are limited to one hour between weigh-ins and competing in a dual meet. The researchers stated that adequate rehydration cannot be achieved if the wrestler cut 5% or more of his total body weight (Weber et al., 2013). With this 5% loss in body weight, some adverse effects include an increase in the following: core temperature, glycogen degradation, lactate levels and heart rate; as well as a decrease in the following functions: strength, both anaerobic

and aerobic power, lactate threshold, cardiac output and stroke volume (Grindstaff & Potach, 2006). In an effort to control the extreme weight loss and prevent further deaths after the loss of the three wrestlers in 1997, the NCAA implemented a weight certification program (Davis et al., 2002). This program was implemented with the goal that significant weight loss can be prevented and athletes would not participate in such extreme measures to compete.

Wrestling Certification Program

Following the wrestler's deaths in 1997, the NCAA mandated that all collegiate wrestling teams follow the policies of the Wrestling Weight Certification Program (WWCP) (Davis et al., 2002). The NCAA, in 1998, made significant rule changes in order to achieve a safer wrestling competition environment (Davis et al., 2002).

These rules changes for safer wrestling include (Davis et al., 2002):

1) Establishing a weight class system that better reflects the wrestling population;
2) Establishing a permanent healthy weight class early in the season for each wrestler;
3) Establishing weigh-ins as close to the match as possible for each wrestler;
4) Establishing weigh-ins for each day of a multiple day tournament;
5) Eliminating tools that are used to accomplish rapid dehydration.

In addition to these rule changes or goals, the NCAA added a weight management program to the sports' rule book (Davis et al., 2002). The section mandates several guidelines for coaches, medical staff and athletes to follow (Davis et al., 2002). The adjusted rules follow a set of specific guidelines that must be followed per the WWCP (Davis et al., 2002). The first section of the rule book indicates who must follow the guidelines and gives specific dates (Martin, 2011). For example, all student athletes whose name appears on the roster and reports prior to February 15th of the season must participate in the WWCP while descending to their lowest weight class

(Martin, 2011). The next sections describe the data entry process, defines an assessor and the specific weight certification procedures (Martin, 2011). The weight certification procedures are outlined below (Martin, 2011):

1) Establish a weight class (WC) – An initial assessment should be done on anyone whose name appears on the roster, at which time the athlete's minimum wrestling weight will be determined. Coaches have 48 hours to accept this weight program for each wrestler; if they fail to accept, the assessment must be performed again.
    a. This calculates lowest allowable weight class and the weekly weight percentage they may lose while descending to their goal weight.
2) Wrestlers may not weigh in at more than one weight class above their set minimal weight class at official weigh-ins, i.e. competitions, and if so they forfeit that weight class and the next weight class becomes their lowest allowable weight.
3) Wrestlers may descend to the lowest allowable weight at no more than 1.5 percent of their body weight per week. This program is calculated after the initial assessment.
4) All official weigh-ins and medical examinations from competition must be submitted to the NCAA.

Davis et al. (2002) suggested in a preliminary investigation of the new NCAA procedures that dramatic weight loss, was not demonstrated. The preliminary investigation conducted by Davis et al. (2002) involved thirty-two athletes during one season and twenty-nine (fourteen returning athletes) the following season. The athletes were only certified to a weight class if they met the NCAA hydration requirements of a specific gravity of 1.020 or below (Davis et al., 2002). Of the thirty-two wrestlers, six did not meet the hydration requirements and were required to repeat the test 24 hours later; and the following year five wrestlers of twenty-nine did not meet

the hydration requirements (Davis et al., 2002). With-in 48 hours all wrestlers had met the hydration requirements (Davis et al., 2002). The study also reported that during the first week of the competitive season, wrestlers did lose a substantial amount of weight, but a rebound effect was noted and the wrestler's weight loss stayed between 1-2 pounds lost per week (Davis et al., 2002). The average weight loss over the course of the first season was 10.8 pounds and the second season average was 13.3 pounds (Davis et al., 2002). According to Davis et al. (2002, pg. 307) "We believe that the NCAA WWCP and corresponding rule changes have begun to break the historic cycle of weight cutting". The researchers found that at testing time the athletes were all well hydrated, at the required 1.020 specific gravity or above as mandated by the WWCP (Davis et al., 2002). However, a weakness in the study was that all subjects knew well in advance about the assessment, and the authors suggested that random hydration tests should be performed (Davis et al., 2002).

Oppliger et al. (2006) found that wrestlers competing in national championships have their weight under control at the time of the championship, as compared to their pre-season test. The participants in this study were wrestlers from DI, DII and DIII national tournaments (Oppliger et al., 2006). The study investigated two aspects of the WWCP: First, body composition assessments and minimal weight protocols between preseason and post-season were compared; and second, weight loss was compared between the day prior to competition and official weigh-ins (Oppliger et al., 2006). These weight measurements were also compared to the wrestlers weights at the end of the first day of competition, to observe any rapid weight gain (Oppliger et al., 2006). The objective of the first part of the study was looking for significant decreases in percent body fat and any minimal weight class changes (Oppliger et al., 2006). The minimal weight class changes refer to the preseason protocol and if any changes needed to be

made throughout the season due to weight loss manipulations by the athletes, i.e., weighing in more than one weight class above the lowest allowable weight class or any lean mass gains throughout the season (Oppliger et al., 2006). The results indicated a significant decrease in weight and body fat percentage between preseason and post-season measurements, but no changes for lowest allowable weight, or minimal weight, as set by the initial certification (Oppliger et al., 2006). The researchers report that positive changes in weight management are observed when compared to weight loss prior to the NCAA mandated changes (Oppliger et al., 2006). In addition, the minimal weight classes set for each wrestler preseason provide good information and weight loss protocols to minimize extreme weight loss throughout the season (Oppliger et al., 2006). The study did not report fat mass loss versus lean mass loss however.

In the second aspect of the study, there was no significance reported within weight classes to suggest rapid weight loss when comparing the day prior to competition and official weigh-ins (Oppliger et al., 2006). In addition, no significance was reported for rapid weight gain at the end of the first day of competition (Oppliger et al., 2006). It was reported that wrestlers remained close to the weight at which they weighed in, compared to the end of the day weights, on average weighing .9 kg more than the official weigh in (Oppliger et al., 2006). These findings suggest that the rule changes by the NCAA, specifically the lowest allowable weight class set preseason, are minimizing rapid weight loss throughout the season and immediately prior to competition (Oppliger et al., 2006). One recommendation following the study, however, is even though the weight management program proves effective to minimize extreme weight loss, hydration was only tested preseason (Oppliger et al., 2006). The researchers suggest a future study be conducted measuring hydration preseason and immediately prior to competition to observe hydration status throughout a competitive season (Oppliger et al., 2006). Measuring

hydration before competition will help determine if wrestlers are weighing in dehydrated and if so, the NCAA policies may need to be revised to protect the athletes from an increased risk of EHI's (Oppliger et al., 2006). Researchers have also shown that competing in a dehydrated state can reduce muscle function and promote fatigue (Judelson, Maresh, Anderson, Armstrong, Casa, Kraemer, & Volek, 2007). Therefore, wrestlers competing in a dehydrated state potentially will experience a decrease in overall performance and have an increases risk to experience EHI.

Buford et al. (2006) conducted a study on the effects of wrestling on specific bodily functions, including hydration and muscular performance. The researchers suggested that perhaps the wrestlers had adapted to the weight cycling and resisted the detrimental effects that extreme weight loss has on performance (Buford et al., 2006). Weight cycling for wrestlers typically is losing excessive weight 24-48 hours prior to competition by extreme measures such as decreased caloric and fluid intake, and exercising in hot environments, including wearing extra clothing (Buford et al., 2006). Then after weighing in and the days following, the athlete will eat and drink sometimes excessively to recover (Buford et al., 2006). Utter, Stone, O'Bryant, Summinski, and Ward (1998) reported that wrestlers who participated in weight cycling and even lost significant amounts of fat free mass were able to maintain strength and power throughout the season. Schmidt, Piencikowski, & Vandervest (2005), however, found that there were significant losses in strength throughout the season with wrestlers that participated in weight cycling, but no differences in power. Buford et al. (2006) suggested that more studies should be conducted focusing on weight cycling and the effects on wrestlers. Buford et al. (2006) found that hydration did not appear to reduce muscular strength, mainly because the wrestlers' hydration state stayed the same throughout the study. The decrease in strength came from some other factor (Buford et al., 2006). The researchers concluded that a study should be done trying

to isolate hydration alone rather than having multiple variables (Buford et al., 2006). One variable that the authors point out was that decreased muscle function can result from not only dehydration but muscle temperature as well; warmer muscle temperature results in faster fatigue compared to a colder muscle (Buford et al., 2006). Also, the loss of body weight was potentially a more significant factor related to the decreases in strength due to the potential loss of muscle for energy (Buford et al., 2006).

Prevention and Care

The job of the medical staff and coaching staff is to educate and protect the athletes on injury prevention (Casa, 2000). Although some injuries may not be controlled, there are measures that can take place to control and minimize some athletic injuries (Casa, 2000). The NCAA implemented the WWCP and coaches, medical staff and athletes must follow the program in order to decrease the chance of unhealthy weight loss (Casa, 2000). One specific detriment that weight loss promotes is dehydration. Dehydration, especially extreme dehydration, can be controlled and should be monitored and prevented by athletes, coaches and medical staff. The WWCP was put into place for that very reason. The NATA also released a position statement that described the effects of dehydration and how to prevent dehydration (Casa, 2000). The position statement also gave suggestions on how to prevent dehydration and how to replenish fluids during intense endurance activities (Casa, 2000). The medical staff should also be able to recognize signs of athletes modifying or decreasing their caloric intake because wrestlers not only decrease fluid intake while trying to cut weight but also their caloric intake (Casa, 2000).

Malnourishment can not only decrease their ability to perform during wrestling but may cause harm to them physiologically long term (Artioli et al., 2010). Some of these physiological

negative effects include cardiovascular dysfunctions, lowered bone density, impaired cognitive function, impaired thermoregulation, hormonal imbalance, mood swings, and overall increased risk for injury due to nutrients not being delivered throughout the body (Artioli et al., 2010). The negative impact on the body's physiological functions may have long term effects on the athlete and can be problematic later on in life. For these reasons, athletic trainers, physicians and coaches must be educated and able to identify signs of malnourishment to prevent any long-term deficits to the athlete. Coaches need to understand that even though scholarships and contracts may be involved, pushing an athlete to such extreme measures to compete are not worth the consequences (Artioli et al., 2010). These consequences have led to multiple deaths, hyperthermia from dehydration of the three wrestling athletes in 1997, and even a heart attack in 1996 of a Judo wrestler triggered by a rapid weight loss regime (Artioli et al., 2010).

Another way that wrestlers lose weight is by taking diuretics, laxatives, diet pills and even forcing themselves to vomit (Steen & Brownell, 1990). The athletes take the pills in order to lose weight rapidly, more specifically for the convenience of a quick fix, rather than using other rapid weight loss techniques such as practicing in hot environments and using sweat suits (Steen & Brownell, 1990). Although these techniques of taking pills to lose weight are banned by the NCAA, not all athletes are tested. The NCAA and NATA could team up and require random testing of the athletes to ensure these measures are not taken to lose weight, perhaps making these random tests closer to competition as that is when these athletes are losing the most weight. Athletic trainers, physicians, nutritionists and strength and conditioning coaches should educate athletes on proper nutrition, especially required for the sport. Proper hydration techniques and perhaps making specific plans for each wrestler should be implemented while the athlete makes the descent to their goal weight. Observing extreme weight loss accomplished by

using techniques such as sweat suits, saunas, and restricted diet and fluid intake, immediately leading up to a competition, and measuring hydration periodically throughout the season, can all be used to help reduce the rapid weight loss routines utilized by wrestlers.

Researchers have found that the changes in the policies set forth by the NCAA have appeared to control the extreme weight loss measures of NCAA wrestlers (Oppliger et al., 2006). Oppliger et al. (2006) stated that "During the championship tournaments at all three collegiate divisions, weight cutting decreased dramatically compared with previous investigations using the same research design" (pg. 969). These findings are specific to the championship tournament, leaving a gap in the literature over the course of the competitive season. The NCAA WWCP requires that wrestlers cannot be certified to a weight class in a dehydrated state (Davis et al., 2002). During the descent to the calculated minimal weight, however, the athletes are no longer required by the NCAA to be tested for their hydration state (Martin, 2011). Following the initial weight certification at the beginning of the season, wrestlers may be participating in weight cycling to achieve their desired weight and as long as at weigh-ins for competition they are within the parameters of the NCAA guidelines, they may wrestle (Davis et al., 2002). Hydration and weight loss are not measured in any other fashion as long as the wrestler is adhering to the weight loss protocol set in place at the beginning of the season (Martin, 2011). The only measurement and recording of this protocol is by submitting official weigh-ins at each dual meet or tournament (Martin, 2011). The gap in research suggests that an investigation of the NCAA WWCP policies should be conducted to assess the hydration state of the wrestlers while making the descent to their minimal weight. These investigations could be used to ensure that the policies in place do promote healthy weight loss. Changes could include hydration testing done at multiple strategic times during a season while weight descents are going on.

Conclusion

To summarize this literature review, researchers have shown that wrestlers are still engaging in weight loss techniques that cause physiological detriments including severe dehydration (Popkin et al., 2010). The NCAA has taken action to reduce the amount of weight cycling and weight loss in response to the death of three wrestlers due to hyperthermia, a physiological complication of dehydration (Oppliger et al., 2006) and to protect the well-being of the athletes (Casa, 2000). The new policies require the wrestler to be certified at a specific weight, and then a weight loss plan specific to the wrestler is created by the OPC for the season (Martin, 2011). Even with the new policies in place, hydration status is only measured once at the beginning of a season, leaving the potential for dehydration throughout the season, especially immediately prior to a dual meet or tournament (Martin, 2011). The initial hydration test, using urine specific gravity, has to be at or below 1.020 sp. gr., in order to certify a wrestler at a given weight; but as the wrestler descends and reaches that weight, the athlete's hydration is no longer factored into weight loss routines (Martin, 2011). Dehydration can lead to many physiological changes including a decrease in cardiovascular function, increase risk of heat illness and even death (Davis et al., 2002). Rapid weight loss also has the potential to result in a decrease in lean muscle mass in addition to fat mass, leading to a potential decrease in performance (Koral & Dosseville, 2009). The priorities of coaches, athletes, athletic trainers, physicians and staff should be the safety and overall well-being of the athlete, and these individuals should be able to recognize and address any extreme weight loss issues in order to protect the athlete.

Chapter 3

Methods

Population

Participants included all volunteer members of a Division II college wrestling team certified on the NCAA weight certification website. Prior to the study, the researcher spoke with the team's coach who agreed to allow the researcher to recruit participants from his team. A total of 10 male participants, aged 19-23 years volunteered for this study, and participated in the initial certification measurements. Nine of those wrestlers competed in a wrestling dual at the second data collection, and five competed in the wrestling dual on the final collection date.

The Setting

All hydration, weight and body composition measurements were conducted by the researcher and the institution's appointed assessor, both certified athletic trainers with no vested interest in the team, and took place in the same Division II collegiate wrestling room in which the participants were recruited and practiced. Hydration and weight measurements took place in mid- December and mid-February, at the same time as the NCAA official weigh-in prior to the wrestler competing in the event. All measurements were conducted by the same assessors and with the same instrumentation.

Procedures

All participants signed a form of consent to voluntarily participate in this study, which was approved by the university's Institutional Review Board (IRB) (Appendix A).

Data was collected three times: the first day of official team practices in mid-October, mid-December and mid-February, as well as weekly weigh-ins (Table 1- Appendix B). Weekly

weigh-ins took place 24-48 hours prior to the official weigh in of the dual meet or tournament. If the wrestlers participated in multiple duals or days in a tournament, the measurement would take place 24-48 hours prior to the first meet or first day of the tournament. The first assessment was conducted by an 'assessor', a qualified individual according to NCAA rules: a Certified Athletic Trainer, registered dietitian or physician. The researcher is a certified athletic trainer and assisted the institution's certified athletic trainer with all measurements. The athletes must go through this certification before competing in that year's season. The assessor took the three site skin fold measurements as required by the NCAA, subscapular, tricep and abdomen, and additionally the more comprehensive 7-site skin fold measurements; specific gravity using a refractometer; and weight using a digital scale. Research shows that seven site skin fold measurements are more accurate in achieving body fat percentage than three site measurements (Jackson & Pollock, 1985). Seven site skin folds were measured using skin fold calipers at the following sites: chest, axilla, tricep, subscapula, suprailliac, abdomen, and thigh (Jackson & Pollock, 1985). The same researcher took all of the assigned measurements on all participants. The data was collected following the weight management program rules set forth by the NCAA. The athletes' urine specific gravity, weight and three site skin fold measurements were all entered into the Optimal Performance Calculator (OPC) on the Wrestling Weight Certification website where the coach had the roster and schedule already verified prior to the data entry. The OPC determines the lowest weight and weight class the athlete can descend to. The wrestler has to follow a weight loss plan and these data points cannot be changed once verified.

The second and third measurements were taken in mid-December and mid-February, respectively. These measurements are not mandated by the NCAA, however the same procedures were followed as the initial assessment; the measurements took place at the same time as the

official weigh-in on a competition day. February 15th however, is the date set by the NCAA that the athlete should have reached their goal weight or weight class and may participate at that class as long as the athlete has not forfeited that weight (Martin, 2011). As stated in the consent form, the specific dates were not announced to the athletes in order to get a true hydration test. The data was not entered into the NCAA website.

Instrumentation

Several instruments were used in this study:

Digital Scale: A Detecto- 439 physician scale was used throughout the study. Weight was reported in pounds to the nearest tenth to remain consistent to the requirements of the OPC.

Optimal Performance Calculator: The optimal performance calculator (OPC) was the tool used to calculate wrestler's weight loss protocol and the wrestler's lowest allowable weight (Table 2 in Appendix C). The OPC can be found at National Wrestling Coaches Association Website (www.nwcaonline.com).

Refractometer: A portable refractometer (REF312ATC), was used to measure hydration status. Urine specific gravity (USG) was used as the hydration measurement with a USG of 1.020 sp. gr. being the mark to be considered hydrated. At this point, the athlete's weight and body composition may be entered to the OPC for the weight descent protocol.

Skin Fold Calipers- Skin fold calipers (Lange C-130) were used to measure body composition in all subjects. The NCAA requires the three measurements: subscapular, tricep and abdomen; but for the purposes of this study, a seven-site measurement was utilized. The seven-sites are chest, axilla, tricep, subscapula, suprailliac, abdomen, and thigh. Research shows that the seven site

average skin fold measurement is more accurate than the three-site measurement (Jackson & Pollock, 1985). The same assessor and calipers were used on all athletes.

Research Design

The independent variable is the wrestlers themselves and the dependent variables are the hydration tests on three different occasions including: skinfold measurements to determine fat mass, lean mass and percent body fat based on three different occasions, urine specific gravity on all three occasions, and weight; and the weekly weigh-ins 24-48 hours prior to competition from the first day of practice to mid-February. If the wrestlers participated in multiple duals or days in a tournament, the measurement would take place 24-48 hours prior to the first meet or first day of the tournament. The study used a repeated measures design of hydration (three times) and skin fold measurements (three times) and weekly weigh-ins 24-48 hour prior to competition (Table 1 in Appendix B). No experimental treatments were administered.

Reliability and Validity

Urine specific gravity (USG) is a standard measure of the concentration of ions in a substance (Armstrong et al., 1998). The number for USG represents the ratio of the density of urine to the density of water (Armstrong et al., 1998). Using urine specific gravity to test for the hydration status of an athlete demonstrates the ratio of solutes to water (Armstrong et al., 1998). The standard set by the NCAA and WWCP is a urine specific gravity of 1.020 sp.gr., and any value greater than 1.020 sp. gr. indicates the wrestler is dehydrated (Martin, 2011).

Skin fold measurements are a two compartment body composition test commonly used in a field setting. The ASCM has established that the seven site skin fold average and calculations are more accurate than a lesser number of skin fold sites (Jackson & Pollock, 1985). Seven-site

skinfold testing shows a better representation of the athlete's body composition than a three-site average. The researcher's validity on skin fold measurements was tested against a criterion researcher. Ten participants' seven-site skin folds were measured three times; two by the researcher and once by the criterion researcher. Reliability statistics were conducted using SPSS version 22 and Cronbach's Alpha Reliability coefficient was reported as .987 for the researcher compared to the criterion researcher. Pearson's correlation coefficient for validity was run with statistical significance set at $p < .05$. Pearson's correlation coefficient was reported at .905 which was significantly different. This indicates that the researcher is reliable for skinfold testing, but was consistently reporting lower values than the criterion researcher. The criterion researcher's mean percent body fat calculations for the ten participants were $18.4 \pm 3.1\%$ compared to the researcher's $15.0 \pm 2.5\%$. The same researcher doing the measures over time, as in this study, is a valid and reliable way to track changes in this study.

Treatment of Data/ statistical analysis

Data was compiled in several Microsoft excel spreadsheets. Weekly weigh-ins were reported in pounds to remain consistent with the OPC calculations. The initial weight certification, including USG, weight and skin fold measurements were entered and submitted for certification on the National Wrestling Coaches Association (NWCA) website, NWCAonline.com website, as well as Microsoft excel. The skin fold measurements, USG and weights from the remaining two hydration test dates were compiled in a Microsoft excel spreadsheet, with body fat percentage being calculated using a skin fold calculation template on Microsoft excel (Jackson, Pollock, & Ward, 1980). Weights were recorded weekly 24-48 hours prior to competition each week, and entered in a Microsoft excel spreadsheet. If the wrestlers

participated in multiple duals or days in a tournament, the measurement would take place 24-48 hours prior to the first meet or first day of the tournament.

Data was analyzed using SPSS version 22 (2013) statistical analysis software. A related-samples McNemer test was conducted to show the differences in hydration status for each wrestler between the initial test date (10/22/15) and 2nd test date (1/09/15) and also between the initial test date (10/22/15) and final test date (2/13/15). A trend analysis was used for weekly weigh-ins showing actual weight loss of the wrestlers. A paired samples t-test was used to compare the mean fat mass loss and lean mass loss. Statistical significance was set at $p < .05$ for all tests.

Chapter 4

Results

A total of 10 male participants aged 19-23 years volunteered for this study. All participants competed in varsity matches for a Division II collegiate wrestling team. The ten participants all completed the NCAA certifications on 10/22/14. Nine of those wrestlers competed in a wrestling dual at the second data collection on 1/9/15, while only five competed in the wrestling dual on the final collection date on 2/13/15. The individual data points for each measurement period are displayed in Appendix D, Table 3, Table 4 and Table 5. On average, the wrestlers lost 3.89 ± 2.34 pounds of fat mass and 3.11 ± 3.31 pounds of lean mass over the 12-week period from the initial certification date to the 2nd test date. On average, the wrestlers lost 3.69 ± 2.80 pounds of fat mass and 2.30 ±5.25 pounds of lean mass over the 17-week period from initial certification to the final test date. Individual wrestler's change in fat mass, lean mass and body fat percentage over time are displayed in Figure 2, Figure 3 and Figure 4, respectively, in Appendix E.

In addition to the fat mass loss and lean mass loss over the study period, 89% of wrestlers (n=9) had a urine specific gravity above 1.020 sp. gr. at the time of official weigh-ins for the 2nd hydration test date, and 100% of the wrestlers (n=5) had a urine specific gravity above 1.020 sp. gr. at the time of the final test date (Appendix D, Tables 4 and 5). No significant findings were reported for weekly weight loss as the wrestlers used official weigh-ins when recording weight. The wrestlers did not record a weight 24-48 hours prior to the official weigh-ins, so rapid weight loss could not be observed.

Body Composition Measurements

Skinfold calculations were run through a paired samples *t*- test. The 2nd test date and final test dates' fat mass and lean mass were subtracted from the initial fat mass and lean mass, respectively, then a paired samples t-test was run to analyze average lean and fat mass lost. On average, wrestlers lost 3.89 ± 2.34 pounds of fat mass and 3.11± 3.31 pounds of lean mass from the initial certification date (10/22/14) to the 2nd test date (01/09/15), which was a 12-week period. The difference of fat mass lost compared to lean mass loss over the first 12 weeks was not significant ($t(8)= -.977$, $p=.357$). On average, wrestlers lost 3.69±2.80 pounds of fat mass and 2.30± 5.26 pounds of lean mass from the initial certification date (10/22/14) to the final test date (02/13/15), a 17-week period. The difference of fat mass loss to lean mass loss over the 17-week period was not significant ($t(4)=.839$, $p=.449$). The descriptive statistics and paired samples t-test are shown in Appendix F, Table 6 and 7.

Hydration testing

Hydration was evaluated on ten wrestlers for initial certification, nine for the second evaluation date and five on the final date. Figure 4 (Appendix E) demonstrates the hydration status of each participant for each trial. The horizontal black line represents the 1.020 sp. gr. standard.

Each trial date is displayed in order by test date, initial (10/22/14), 2nd (01/09/15), and final (2/13/15) for each individual participant, labeled on the x-axis as part. 1, part. 2, etc. The figure shows that only one participant (participant 4 in the 2nd trial) was hydrated at the time of official weigh-ins. Participant 2 and 7 were unable to provide a sample during the second trial measurements.

A related-samples McNemar test in SPSS version 22 (2013) was utilized to determine significance between the expected hydration status and the actual hydration status of the wrestlers. The expected hydration status is that all wrestlers should be hydrated (sp. gr. ≤ 1.020) at the time of weigh-ins, similar to the initial certification. There was a significant difference in wrestlers not being hydrated from initial certification to the second hydration test ($p= 0.008$). The percentage of wrestlers not hydrated was calculated using Microsoft excel. On the 2nd test date, 89% of wrestlers (n=9) were considered dehydrated, and 100% of wrestlers (n=5) were considered dehydrated at the final test date. The criteria to be considered hydrated was a specific gravity measurement of 1.020 sp. gr. or less, the standard set by the NCAA. A related-samples McNemar test for significance was not run on the difference between the initial hydration test date and the final test date as there was not enough data collected.

Weekly weight

Weight was to be measured weekly, 24-48 hours prior to competition, to observe possible rapid weight loss when compared to official weigh-ins. However, wrestlers used official weigh-ins rather than weighing 24-48 hours prior to competition as weekly weigh-ins (Appendix G). No statistical analysis was run due to the missing data, therefore no significance was reported when observing for rapid weight loss.

Chapter 5

Discussion

The purpose of this study was to observe the weight loss patterns in collegiate wrestlers throughout the Division II collegiate wrestling season. The weigh-ins performed on the hydration test dates, which are considered NCAA official weigh-ins, were to be compared to the wrestler's weigh-ins 24-48 hours prior to the competition. Additionally, at the time of official weigh-ins, urine specific gravity was measured to determine if the wrestlers were in a hydrated state prior to competition. Body composition was also measured at each hydration test date to determine any lean mass loss and/or fat mass loss.

The first hypothesis and research question were not supported following the study. Weekly weigh-ins were to be recorded 24-48 hours prior to competition each week, and then compared to the official weigh-in of the first dual meet or first day of a tournament that week. Wrestlers did not weigh-in 24-48 hours prior to competition; instead only official weigh-ins were recorded. The researcher was not present for the weigh-ins 24-48 hours prior to the competitions, therefore the researcher did not have control over when the weigh-ins took place. This did not allow for the researcher to monitor any rapid weight loss leading up to a competition as each weigh-in would be roughly the same.

The second hypothesis was supported following the study based on seven of the nine wrestlers who were able to provide a hydration sample in the second data collection (1/09/15). The two wrestlers that were unable to provide a sample, simply because they stated they couldn't produce a sample, were considered not hydrated, and recorded as such in the related-samples McNemar statistical analysis. The NCAA standard to be considered hydrated is a urine specific

gravity of 1.020. Of those seven, only one was in a hydrated state. At the time of the third test date (2/13/15) all 5 wrestlers weighed in in a dehydrated state according to the NCAA standards. These findings support the hypothesis that wrestlers are weighing in dehydrated, using the NCAA standard of 1.020 sp.gr., one hour before a dual meet or tournament. The NCAA standards for initial weight certification, a urine specific gravity of 1.020 sp. gr., must be met in order to certify a wrestler at a given weight. As the wrestler descends and reaches that weight, the athlete's hydration is no longer factored into weight loss routines (Martin, 2011). The physiological effects of fluid loss may result in detrimental effects to the cardiovascular system, which then may result in changes to the musculoskeletal system (Casa, 2000). Common side effects of dehydration include an increased heart rate, decreased maximum cardiac output, reduced muscle function, and dehydration promotes fatigue in the athlete (Judelson et al., 2007). The physiological effects of dehydration may potentially cause a decrease in performance (Judelson et al., 2007). The researcher's opinion is measuring hydration only during preseason is not a valid measurement, if hydration is not monitored throughout the season. Dehydration can have many adverse effects on athletes including decreased performance and increased risk of heat illnesses.

The third hypothesis was also supported following the study that in addition to being dehydrated, wrestler's weight loss came from both fat mass and lean mass. Significance wasn't found between the amounts of fat mass lost and lean mass lost, but the weight loss ideally should only be from fat mass loss. This is cause for concern that no significance was reported between fat mass loss and lean mass loss, leaving the potential for wrestlers to experience a decrease in performance, due to loss of lean mass. In addition, Powers and Howley (2012) state that the recommended range of percent fat values for active individuals are 5-15% for males. This

indicates that at least 5% body fat is essential for normal physiological functions (Powers & Howley, 2012). In the current study, several wrestlers fell under that 5% standard, which may not only affect their health but may negatively affect performance as well.

The average fat mass and average lean mass lost from initial certifications to the 2nd hydration test date, a total of 12 weeks, was very similar: 3.89 pounds fat mass lost and 3.11 pounds lean mass lost, indicating that wrestlers are losing fat mass and lean mass. The wrestlers lost an average of 3.69 ± 2.80 pounds of fat mass and 2.30 ± 5.25 pounds of lean mass over the 17-week period from initial certification to the final test date. The data from the 5-week period between the 2nd and final testing date, suggests that wrestlers were losing more fat mass than lean mass, potentially balancing out type of mass lost, creating a new set point for weight. This aligns with the study by Davis et al. (2002) that reported that initially wrestlers lost a significant amount of weight, but a rebound effect was noted; and the wrestlers' weight was maintained closer to the desired weight classes, later in the season. Davis et al. (2002) did not measure body composition to distinguish the type of body mass the wrestlers lost or what type of mass was gained to create the rebound effect. The data in the current study also shows that wrestlers were gaining lean mass back, suggesting that wrestlers were closer to their goal weight later in the season and gaining lean mass as a result of training. Even though the current study did show that on average the wrestlers were gaining lean mass between the 2nd test date and final test dates, their lean mass did not return to the baseline in which the wrestlers started with at initial certifications. The wrestlers still had decreased lean mass at the final test date when compared to the initial certification date, potentially affecting performance.

The initial ten volunteers at the time of certification did not represent all ten weight classes. The represented weight classes can be seen in Appendix D, Table 3, Table 4 and Table 5. At the time of the 2nd dual, only nine of the same wrestlers participated in the dual, representing eight of the ten weight classes; there was an additional exhibition match at the 125 pound weight class. The coach explained that at this particular dual, he gave some varsity wrestlers a rest weekend as the opponent was not as competitive. In addition to the rest, some of the wrestlers that did wrestle on this date either wrestled up or down in a weight class to fill in for these varsity wrestlers. For example, the 174 pound wrestler at this dual was certified at 157 pounds. He wrestled up two weight classes to fill in for a varsity wrestler being rested at this meet. The NCAA rules allow for the wrestlers to wrestle up two weight classes without forfeiting their previously determined lowest allowable weight class (Martin, 2011). At the final test date, the varsity wrestlers competed and were placed back into their respective certified weight class. Only five wrestlers were the same on that final date. Coaches making these decisions of whether a wrestler participates in every meet and at what weight class is part of the wrestling culture, mainly due to the physiological demands of the sport. Coaches constantly evaluate the most fit athlete for each weight class and competition, and will often give athletes a week off, especially near regional type tournaments. This creates a limitation to the current study as it is hard to have research design control, due to the potential for participants to change weight classes or not wrestle at every competition.

Dehydration in sports can greatly affect performance but more importantly can have severe safety implications on the athlete (Casa, 2000). Adequate fluid intake is required in order to maintain core body temperature via evaporation of sweat (Casa, 2000). If the body is unable to produce sufficient sweat due to a decrease in body fluids, body temperature will increase putting

the athletes at risk for heat stroke (Casa, 2000). In addition to heat related illnesses, cardiovascular function may be compromised without adequate hydration (Powers & Howley, 2012). Without proper hydration, the viscosity of the blood will increase resulting in increased heart rate and possibly leading to musculoskeletal compromises (Powers & Howley 2012). The increased viscosity hinders the delivery of oxygen and other essential nutrients to the working muscles, and to muscles during recovery (Powers & Howley, 2012).

Davis et al. (2002) did a preliminary study that found wrestlers lost a significant amount of weight in the first week following the certification test date. These wrestlers however had a rebound effect, gaining some of the weight back, then losing the recommended weight thereafter (Davis et al., 2002). Hydration was not measured at any other point in the season and there was no distinction of fat mass loss or lean mass loss. Even though the wrestler's weight loss fell within the recommended weight loss requirements of 1-2 pounds per week (Davis et al., 2002), neither hydration or type of body mass lost were measured, leading to the purpose of the current study. Lean mass loss also has adverse effects on performance, potentially decreasing strength and power output by the athlete (Koral & Dosseville, 2009). The wrestlers in the current study lost on average 2.30 ± 5.25 pounds of lean mass over the 17-week study, gaining back slightly from the 3.11 ± 3.31 pounds of lean mass lost at week 12. Although performance wasn't measured in the current study some wrestlers admitted to feeling performance deficits and early fatigue while competing.

During the researcher's time spent with the participants, many had testimonials regarding the NCAA's policies. The testimonials were not conducted through formal interviews, measured or analyzed in the current study. The participants that volunteered agreed with the researcher's

questions about hydration, rapid weight loss, and they hoped that in the future the culture of wrestling would change. One participant acknowledged that there is a practical way to descend to a lowest allowable weight, but as a college student he admitted to not having the means to eat a healthier diet. The participants in the current study suggested that the lowest allowable weight class or percent that a wrestler is allowed to lose is reassessed and hydration should be a part of the weight loss protocol throughout the season.

In the researcher's opinion, the weight loss protocol has not changed because to date, all investigations have shown that extreme weight loss has been controlled. Oppliger et al. (2006) found that wrestlers competing in national championships have their weight under control at the time of the championship, as compared to their pre-season test. The study also concluded that positive changes in weight management are observed when compared to weight loss prior to the NCAA mandated changes stating the lowest allowable weight class set during preseason controlled weight loss throughout the season (Oppliger et al., 2006). Even with these findings, the study did not measure hydration or distinguish between lean mass loss and fat mass loss, so the weight loss may have been a combination of the three (Oppliger et al., 2006). Lean mass and fluid loss potentially can have negative effects on performance including muscle function, metabolic pathways and increasing the onset of fatigue (Powers & Howley, 2012).

The wrestlers in the current study stated that they did notice the decrease in their own performance and how quickly they become fatigued when they are required to lose weight immediately prior to a dual or tournament. The second and third testing sessions were conducted on weekends that the wrestlers competed in three duals for three consecutive days. Each day the wrestler had to achieve the same weight requirements. Additionally, even though travel was not a

factor in the study or measured, wrestlers described that when travel was required, not only did they have to lose the weight but on the road as well. Wrestlers said that the fatigue that they experience while losing weight feels amplified when on the road. The differences reported while traveling was the time spent traveling, sleeping in unfamiliar places, while on a restricted diet to maintain or lose weight prior to wrestling. Changing routines and rhythms can result in malaise, loss of appetite, fatigue and disturbed sleep, and all of these factors can potentially result in decreased performance (Clark, 2014).

On the day of the duals, the wrestlers have a pre-dual practice typically 3-4 hours pre-competition, mainly consisting of light drilling and some technique. During this practice, the coach instructed the wrestlers to participate at less than 50% effort with the purpose being a dynamic, sport specific warm up to prepare for the upcoming competition. Following this, the athletes weigh themselves to see if they are on point or have some extra weight to lose. While observing this, the researcher saw that there were three wrestlers that required extra weight to be dropped. The wrestlers wore sweat suits while drilling and running to shed the extra weight. This typically lasted for 45 minutes following the pre-dual practice, thus the wrestler just participated in approximately 1.5 hours of a somewhat strenuous workout prior to the actual competition.

One of the participants failed to make weight on three separate occasions during the season, and at each of the testing sessions this particular wrestler participated in longer pre-dual practices than any other wrestler. The wrestler was at 201 pounds at initial weigh-ins making it seem that he only had to lose 5 pounds to make weight. The researcher discussed this with the athlete to learn that during the off season his weight is between 230-235 pounds. That total weight loss could account for the tough time the participant had losing weight, and between

duals, he stated he would gain 10-15 pounds and have to lose that prior to each dual. The testimonials and/or discussions between the participants and the researcher were not conducted as formal interviews, therefore no measurements for significance were utilized.

Recommendations

Future research on the topic of wrestler's health and well-being, while still performing at peak levels, should include participants at all levels of wrestling, including peewee to Olympic wrestling. A longitudinal study for all levels of wrestling, including youth, high school, collegiate and Olympic wrestling, that monitors weekly weight loss, even on a daily basis, over the course of several seasons, would prove beneficial to see if wrestlers do engage in unsafe weight loss techniques leading to dehydration and decreased performance. Conducting a longitudinal study would be beneficial to observe weight fluctuations in-season and off-season, and also observe any differences in weight loss patterns by the wrestler's experience levels (i.e., freshmen vs. seniors). The same researchers should be present for all measurements and follow the participants throughout the entire study make sure athletes and coaches are compliant with the research design.

The current study initially aimed to look at rapid weight loss immediately prior to a dual meet or tournament, however the team did not record weigh-ins 24-48 hours prior to competition. If the researcher was with the team every week throughout the process, perhaps this aspect would have been recorded on the specified dates. Monitoring of any wrestling team will require close attention to make sure all participants are compliant with the research design. Future studies may also look at lean mass loss vs fat mass loss and evaluate for any performance deficits that correlate with lean mass loss. Future research would be beneficial for all levels of

wrestling including youth, high school, collegiate and Olympic wrestling. Future research could benefit from a mixed methods design adding interviewing of athletes throughout this process to gain more insight into wrestler's thoughts and experiences with 'making weight", and NCAA policies.

The researcher's opinion is the current NCAA policies considering weight loss plans for wrestlers is a 'band-aid' fix for the death of three wrestlers in 1997. After completing this research, weight loss appears to be controlled by the OPC protocol, however, the research lacks on the type of mass lost, weight loss/gain cycling, and when the weight is lost. Even though wrestlers stay within the OPC recommendations for weight loss, rapid weight loss may be occurring 24-48 hours prior to competition. In this study, on average, wrestlers lost a similar amount of fat mass and lean mass. Lean mass loss could adversely affect performance by reducing strength and power at the time of competition. There is also a gap in the research regarding the assessment of the hydration state of the wrestlers while making the descent to their minimal weight. Research has shown that even as little as a 3% drop in the body's hydration status can have detrimental effects on physiological function (Casa, 2000). Changes to the protocol could include hydration testing done at multiple strategic times during a season while weight descents are going on.

Chapter 6

Conclusion

Summary of Major Findings

The evaluations took place on three separate occasions, measuring hydration using urine specific gravity, skin fold measurements, and official weigh-ins. Weekly weigh-ins also took place from the initial assessment to the conclusion of the study, however the wrestlers only recorded weekly weigh-ins instead of recording a weight 24-48 hours prior to competition. This did not allow the researcher to observe rapid weight loss patterns immediately prior to official weigh-ins. The independent variable was the wrestlers themselves and the dependent variables are the hydration tests on three different occasions. The three test dates included skinfold measurements to determine fat mass, lean mass and percent body fat, urine specific gravity, and official weigh-ins; and the weekly weigh-ins 24-48 hours prior to a competition and were compared to official weigh-ins, from the first day of practice in October to mid-February.

Ten male Division II collegiate wrestlers volunteered to participate and were certified at the beginning of this study. Nine of those wrestlers competed in a wrestling dual at the second data collection, while only five competed in the wrestling dual on the final collection date. The hypotheses and research questions, along with the study results, are summarized below:

Hypotheses

H1: It was hypothesized that even though a weekly weight descent timeline is in place following the NCAA certification, wrestlers would still participate in rapid weight loss techniques 24-48 hours prior to competition. Rapid weight loss was not observed in this study as the wrestlers did not record weigh-ins 24-48 hours prior to competitions.

H2: It was hypothesized that the wrestler's weight loss would not coincide with the urine specific gravity measurement at the beginning of the season, indicating that the wrestlers were dehydrated at weigh-ins. The hypothesis was supported as 89% of the wrestlers (n=9) were in a dehydrated state at the time of official weigh-ins during the second hydration evaluation, and 100% of the wrestlers (n=5) were dehydrated at the final hydration evaluation.

H3: It was hypothesized that monitoring wrestler's weight loss using skin fold measurements would show that wrestlers were not only losing fat mass and fluids but also lean mass while participating in rapid weight loss techniques. This hypothesis was supported as the wrestlers weight loss came from both fat mass and lean mass. The average fat mass loss compared to lean mass loss was very similar which is a significant finding, because the goal is to lose fat mass as opposed to lean mass.

Research Questions

RQ1: Do wrestlers participate in rapid weight loss 24-48 hours prior to competition rather than losing the weight gradually throughout the season? Additionally, once the wrestlers reach the lowest allowable weight, do they maintain a reasonable weight range week to week so they don't participate in rapid weight loss? The wrestlers did not record weigh-ins 24-48 hours prior to official weigh-ins, so conclusions about rapid weight loss cannot be made.

RQ2: Were wrestlers hydrated at weigh-ins for an NCAA wrestling competition, as determined by a urine specific gravity of 1.020 sp. gr. or lower? The majority of wrestlers, 89% at the second hydration test date and 100% at the final hydration test date, were dehydrated at the time of official weigh-ins. The criteria to be considered hydrated was a urine specific gravity of 1.020 sp.

gr. or less. If an athlete was unable to produce a sample, that wrestler's data was recorded as being dehydrated.

RQ3: Were wrestlers losing lean mass and water in addition to fat mass when participating in rapid weight loss techniques? On average, wrestlers lost similar amounts of fat mass and lean mass while descending to the lowest allowable weight class; and in addition, the majority of wrestlers weighed in dehydrated prior to competition, indicating fluid loss.

Overall, findings of this study demonstrated that wrestlers are not hydrated at the time of official weigh-ins immediately prior to a competition despite being certified at the beginning of the season. Additionally, wrestlers lost similar amounts of fat mass and lean mass; it can be assumed that the loss in lean mass is not the desired outcome while descending to the wrestler's lowest allowable weight class, since this loss in lean mass may compromise performance.

Practical Applications

The practical applications for this study include education for coaches, athletes, athletic trainers and strength and conditioning coaches. The results of this study provide an open door to further research regarding hydration and weight loss in collegiate wrestlers. This study was different from previous literature as this study utilized unannounced test dates to measure hydration status to compare to the NCAA certification requirements. The NCAA requires wrestlers to have a specific gravity of 1.020 sp.gr or less in order to be considered hydrated and be certified to a lowest allowable weight class (Casa, 2000). In addition, the current study measured body composition for all three test dates to determine lean mass and fat mass loss while wrestlers were descending to their lowest allowable weight class. Previous research focused more on the wrestlers following the NCAA weight loss requirements determined by the

OPC on the certification date. The literature states that extreme weight loss seemed to be under control, however neither hydration nor type of mass lost was measured during the studies (Garthe et al., 2011; Oppliger et al., 2006). Coaches. and athletes need to be educated regarding the findings of these studies and athletic trainers need to be aware of the signs and symptoms, and implement a possible program to reduce the rate of dehydration and lean mass loss in wrestlers. In addition to educating wrestlers, coaches and athletic trainers, the NCAA policies may need to be revised following further investigations of hydration status and wrestler's participation in rapid weight loss techniques.

Conclusion

Evaporation during exercise is the primary mechanism of heat loss (Powers & Howley, 2012). The function of sweat evaporating off the skin is to regulate core temperature; without sweat and evaporation, the athlete's core temperature could rise rapidly (Casa, 2000). Sweating causes loss of body fluids, and if the fluid intake is less than the evaporation, dehydration will occur (Powers & Howley, 2012). If athletes start exercise activity in an already dehydrated state, they are at a greater risk for decreased performance, physiological changes such as cardiovascular risks, metabolic pathway changes and an increased risk to experience exertional heat illness (Casa, 2000).

The results of the current study show that wrestlers are in a dehydrated state, as well as losing lean mass while descending to the desired lowest allowable weight, over the course of a collegiate wrestling season. These factors not only can hinder performance but also pose a safety risk to the athletes. Nutritional programs may be useful when creating strength and conditioning programs to help monitor and allow the athlete to stay healthy and achieve optimal performance.

After observing the wrestlers during this study, the researcher found that the coaches and staff are putting forth efforts to minimize rapid weight loss; however the dehydration at the time of competition and lean mass loss over the course of a season is still a major concern. Research utilizing multiple teams and seasons is necessary to test the reliability and validity of the NCAA weight certification program, and to make any necessary changes to help protect the athletes from acute and/or chronic injury.

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Appendix A

RESEARCH PARTICIPANT CONSENT FORM

The Use Hydration status to Monitor how Division II Collegiate Wrestlers Achieve Lowest Allowable Weight Class.

Ashley Voss
Adams State University
Department Of Human Performance and Physical Education

Informed Consent for Participation in Research

The purpose of this study is to observe the weight loss patterns that collegiate wrestlers engage in throughout the season, following the NCAA mandatory hydration weight certification. Additionally, observation will be made involving the NCAA weight descent timeline and the actual timeline the wrestler loses weight by looking at the trends of weekly weigh-ins. Also the three urine specific gravity measurements will be compared, using the first one as a baseline, because following the certification date, hydration is not required by the NCAA to be tested again. The NCAA requires that wrestlers cannot lose more than 1.5% body weight per week while dropping to the lowest allowable weight class, set by the NCAA policies. Initial measurements and weekly weigh-ins will be obtained on all athletes choosing to participate in this study and certified on the selected Universities wrestling roster and the remaining two hydration measurements will be obtained at the official weigh-in on the wrestlers competing in a dual or tournament in mid-December and mid-February and considered Varsity Wrestlers. This study will be observations and data collected will be Urine Specific Gravity, skin fold measurements and weigh in's. All data will be kept confidential and the risks of this study are very minimal due to it being an observation study. There will be no remuneration or compensation for participation in the study.

Participation is voluntary. If you agree to participate you will be asked to take part in weight and hydration related measurements on three separate occasions: 1) The NCAA Wrestling Weight certification Program (WWCP) date, on or before the first day of practice, 2) and 3) two dates not specified for randomization purposes, one during mid-season and another close to the WWCP deadline February 15th; as well as weekly weigh ins. All measurements will be conducted in the same universities wrestling room.

Procedures

6) Consent forms and questionnaire filled out for demographic purposes
7) Height and weight measured using a stadiometer and digital scale respectively; weight measured on all occasions, weekly weigh-ins and 3 hydration test days.
8) Seven site, skin fold measurements using calipers, on three hydration test days;
    a. Seven site skin fold measurements; Chest, axilla, tricep, subscapula, suprailliac, abdomen and thigh. Body fat percentage will be calculated using an excel spreadsheet embedded calculations.
9) Urine sample for urine specific gravity measurement, measured using a refractometer.

Duration of Participation

The duration of this study will be over the course of a DII collegiate wrestling season, from mid-October to mid-February. The participants will be involved in one measurement session that is already mandatory according to the NCAA rules and regulation. The duration of the three hydration measurements will last approximately 4-6 minutes per individual wrestler.

Benefits

The benefits of this study allow wrestlers to review and monitor weight loss practices and determine if the weight loss is conducted in a healthy manner. Also, the hydration status prior to a match can be important for performance, and educating athletes and coaches on the importance of hydration and performance will prove as a future benefit. Next, the findings of this study could potentially show that the wrestler's weight loss doesn't coincide with the urine specific gravity measurements at the beginning of the season, leaving them potentially dehydrated and at risk for heat illness and decrease cardiovascular function, and opening doors to further research the weight loss protocol in place by the NCAA. Lastly, the athlete will be able to monitor their weekly weight loss or gain; knowing their weight and body composition from skinfolds can keep them on track to meet their weigh-in goals. Having weekly weigh-ins and 3 body composition measurements to monitor weight loss can potentially encourage healthy weight loss in the future rather than participating in rapid weight loss the week of competition.

Risks and Discomforts

There is very minimal risk involved due to the observational nature of this study. Every professional effort will be made to minimize any risks involved in this study. Minimal discomfort and/ or bruising can occur during skin fold measurements. Also, athletes may get discouraged if their weekly weight goals or weight to compete are not met.

Confidentiality

Participation is voluntary and will be held confidential. You may choose not to answer any question you do not want to answer and/ or you may withdraw from participation at any time without penalty. Names will not be used in the study, participants will be assigned a number and group data will be reported. Data will be locked under a password protected computer for seven years in which the researcher only has the password. Adams State University reserves the right to use the results of this study for future research and/or presentation of results. In such cases, participants will be asked to sign a release form freeing all collected information prior to its use by the institution or researcher. If research is used in a public forum, data will be reported as a group without individual or school identification.

Inquiries:

Any questions or concerns regarding this study are welcomed. For questions please contact the researcher of the study, Ashley Voss, at vossaj@grizzlies.adams.edu or 719-850-2331. Participants may also contact the Adams State University IRB chair, Rob Demski, at rmdemski@adams.edu or (719)587-7216.

AUTHORIZATION: I have read the above and understand the discomforts and inconvenience of this study as well as the benefits and risks. I, _____ (printed name of participant) agree to participate in this research. I understand that I may later refuse to participate, and that I may withdraw from the study at any time. I have received a copy of this consent form for my own records.

_____ _____

Participant's Signature Date

_____ _____

Researcher's Signature Date

ADAMS STATE COLLEGE
INSTITUTIONAL REVIEW BOARD
Approved on: 11-7-14
Expires on: 11-7-15

Adams State College

Request to obtain approval for the use of human participants – expedited review

Date: October 1st, 2014

To: **Adams State College**

Request to obtain approval for the use of human participants – expedited review

Date: October 1st , 2014

To: Rob Demski, ASU Institutional Review Board

Name: Ashley Voss
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Subject: The Use Hydration status to Monitor how Division II Collegiate Wrestlers Achieve Lowest Allowable Weight Class.

Others in Contact with Human Participants:

Research Assistants: Josh Fulmer, MS ATC; Naomi Brown, MS ATC.

The title of the research: The Use Hydration status to Monitor how Division II Collegiate Wrestlers Achieve Lowest Allowable Weight Class.

Objectives of the research: Wrestlers continually subject themselves to unhealthy weight loss techniques in hopes to gain a competitive edge or simply to achieve the desired weight class. There is great risk involved in rapid weight loss routines, specifically dehydration, and can have many adverse effects on wrestlers including heat illness, cardiovascular risk and even death. Following the three deaths of wrestlers in 1997, the NCAA and other governing bodies took action to create and promote safer weight loss routines. Although improvements have been made, wrestlers still engage in rapid weight loss immediately prior to competition putting them at risk of dehydration and other physiological function compromises. Unfortunately these techniques are a part of the wrestling culture and has been for many years, education and research is needed to inform the culture of the dangers of rapid weight loss and dehydration. The purpose of this study is to observe the weight loss patterns throughout the Division II collegiate

wrestling season. Specifically, observing extreme weight loss immediately leading up to a competition will be compared to the gradual weight descent, or lack of, in the weeks prior to competition. Furthermore the purpose of this study is to gather information to educate athletes and coaches on the dangers of rapid weight loss and refer them to professionals in order to lose the weight in a healthy manner. The wrestlers will be participating in their normal training schedule and routines.

Benefits

The benefits of this study allow wrestlers to review and monitor weight loss practices and determine if the weight loss is conducted in a healthy manner. Also, the hydration status prior to a match can be important for performance, and educating athletes and coaches on the importance of hydration and performance will prove as a future benefit. Next, the findings of this study could potentially show that the wrestler's weight loss doesn't coincide with the urine specific gravity measurements at the beginning of the season, leaving them potentially dehydrated and at risk for heat illness and decrease cardiovascular function, and opening doors to further research the weight loss protocol in place by the NCAA. Lastly, the athlete will be able to monitor their weekly weight loss or gain; knowing their weight and body composition from skinfolds can keep them on track to meet their weigh-in goals. Having weekly weigh-ins and 3 body composition measurements to monitor weight loss can potentially encourage healthy weight loss in the future rather than participating in rapid weight loss the week of competition.

Risks and Discomforts

There is very minimal risk involved due to the observational nature of this study. Every professional effort will be made to minimize any risks involved in this study. Minimal discomfort and/ or bruising can occur during skin fold measurements. Also, athletes may get discouraged if their weekly weight goals or weight to compete are not met.

Methods of procedure:

All participants will be asked to sign a form of consent to participate in this study. The participants will also complete a short demographic and history survey. The survey is attached for further detail.

Data will be collected 3 times from the first day of official team practices mid-October, mid-December and mid-February as well as weekly weigh-ins. The duration of the three hydration measurements will last approximately 4-6 minutes per individual wrestler. The first assessment was conducted by an 'assessor', a qualified individual according to NCAA rules; a Certified Athletic Trainer, registered dietitian or physician. The researcher meets the criteria of assessor as a certified athletic trainer. The athletes must go through this certification before competing in that year's season. The assessor will take the required (by the NCAA) skin fold measurements, chest, abdomen and thigh, and additionally the 7 site skin fold measurements, specific gravity using a refractometer and weight using a digital scale. Research shows that seven site skin fold measurements are proves to be more accurate in achieving body fat percentage than three site measurements. Seven site skin folds will be measured using skin fold calipers at the following sites; chest, axilla, tricep, subscapula, suprailliac, abdomen, and thigh. The same

assessor should take all of their assigned measurements on all wrestlers. The data is all collected following the weight management program rules set forth by the NCAA. These data points are then entered into the Optimal Performance Calculator (OPC) on the NCAA website where the coach should have the roster and schedule already verified prior to the data entry. The OPC will determine the lowest weight and weight class the athlete can descend to. The wrestler has to follow a weight loss plan, and cannot lose greater than 1.5% of body weight per week. These data points cannot be changed once verified.

The second and third measurement was taken in mid-December and mid-February respectively. This measurement is not mandated by the NCAA, however the same procedures will be followed as the initial assessment, and these measurements will take place at the same time as the official weigh-in for that competition. February 15th however, is the date set by the NCAA that the athlete should have reached their goal weight or weight class and may participate at that class as long as the athlete has not forfeited that weight (Martin, D, 2011). As stated in the consent form, this date was not announced to the athletes in order to get a true hydration test. The data was not recorded into the NCAA website. There will be no remuneration or compensation for participation in the study.

Research Design: Data will be analyzed using SPSS statistical analysis software. The study will use an observational repeated measures design in which no treatments will be administered. The independent variable in this study will be the wrestlers and the dependent variables will be the three times hydration testing; urine specific gravity, skin folds and weight; and the weekly weigh-in weights. A regression analysis will be used for weekly weigh-ins as well as a correlation test. The correlation test will compare the actual weight loss to the NCAA OPC projected weight loss.

The Setting: All hydration and weight measurements will be conducted in the selected University's wrestling room. The initial measurement will be on or before the first day of practice, mid- October as mandated by the NCAA. Hydration and weight measurements in mid-December and February sessions will take place at the same time as the NCAA official weigh-in prior to the wrestler competing in the event. Weekly weigh-ins on a digital scale in the wrestling room will be recorded every Thursday prior to the practice session beginning

***Participants*:** Initial participants will include members on the selected University's wrestling roster, maximum of 40 subjects, certified on the NCAA weight certification website. Data will be analyzed on two wrestlers representing each weight class; and are considered varsity. If a varsity wrestler is unable to compete through the whole season, an alternate will fill that wrestlers place in all subsequent hydration testing days. All wrestlers were certified by following the policies of the NCAA lowest allowable weight class procedures.

Protection Measures

Participation is voluntary and will be held confidential. You may choose not to answer any question you do not want to answer and/ or you may withdraw from participation at any time without penalty. Names will not be used in the study, participants will be assigned a number and group data will be reported. Also, the school in which the data will be collected will not be identified in the research. Data will be locked under a password protected computer for five

years in which the researcher only has the password. Adams State University reserves the right to use the results of this study for future research and/or presentation of results. In such cases, participants will be asked to sign a release form freeing all collected information prior to its use by the institution or researcher. If research is used in a public forum, data will be reported as a group without individual or school identification.

Consent: Participants will be asked to read over and sign the consent form before any testing begins. The informed consent is attached separately.

Changes: If any changes are made to the research I will contact the IRB immediately and fill out the needed paperwork.

Tracey L Robison 11-7-14

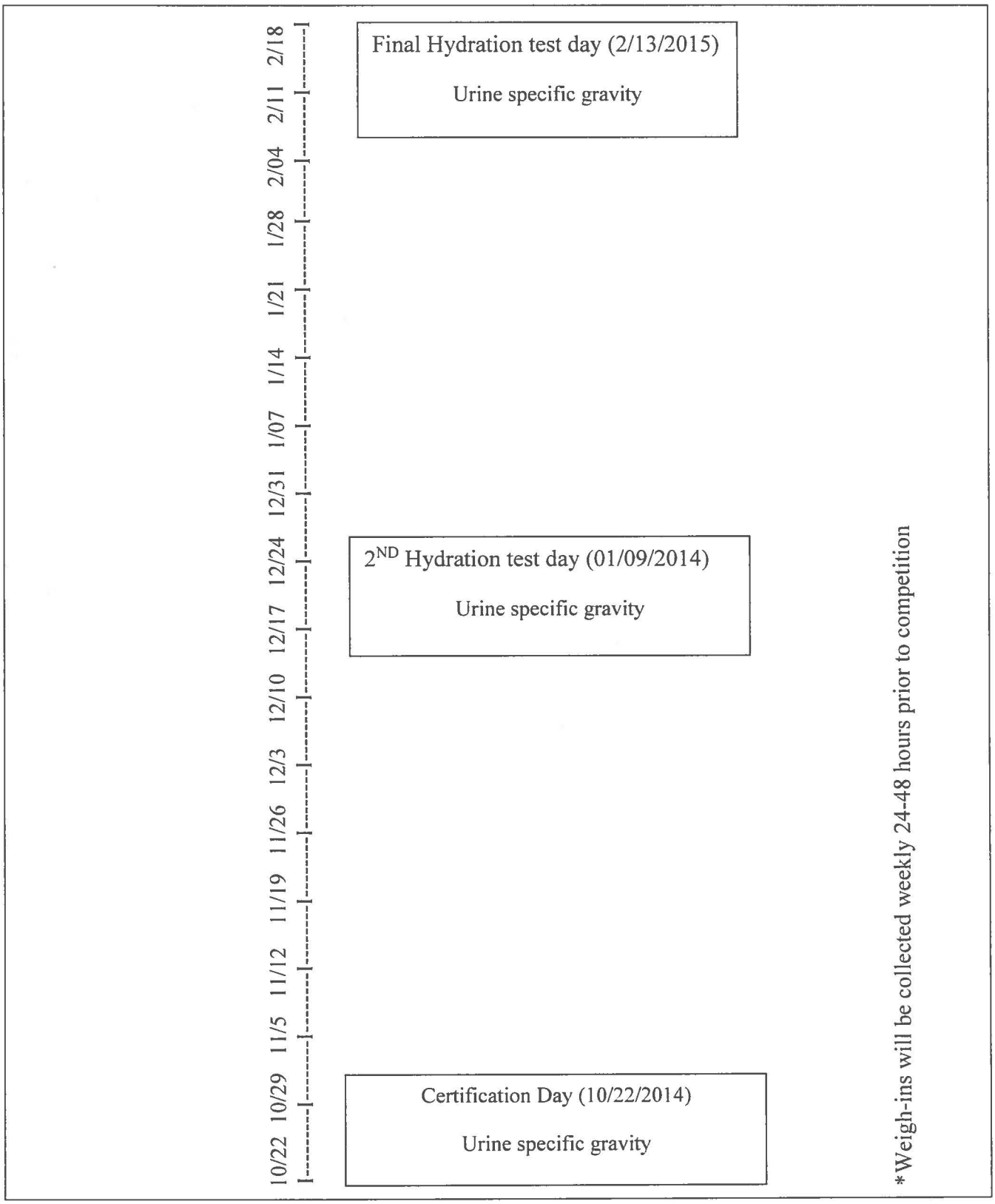
Name and Signature of Department Chair or Appropriate Person Date

Robert Dengler 11-7-14

Name and Signature of IRB Chair Date

Appendix B

Table 1. Time line of data collection



Appendix C

Table 2. Optimal performance calculator collection sheet.

NWCA OPC Hydration Measurements 2014 Wrestling 2014-2015													
Last Name	First Name	Weight	Specific Gravity	Subscap 1	Tricep 1	Abdomen 1	Subscap 2	Tricep 2	Abdomen 2	Supscap 3	Tricep 3	Abdomen 3	Comments

Note: The data collected and entered into the Optimal Performance calculator determines the lowest allowable weight class for each wrestler and creates a weight loss program based off of fat mass for each individual. A wrestler must be hydrated at less than or equal to 1.020 sp. gr. in order to complete the other initial assessment measurements, skin folds and weight, and to certify at a weight class. Also the wrestler may not lose more than 1.5% body fat each week while dropping to their lowest allowable weight and can't drop 5 % body fat total, which is calculated by the OPC (NCWA, 2014).

Appendix D

Table 3. Certification Date (10/22/2014)

Participant	Age (years)	Desired weight class (lbs)	Specific Gravity	Weight (lbs.)	Body Density (g/cm^3)	% Body Fat	Fat Mass (lbs.)	Lean Mass (lbs.)
1	21	133	1.012	137.4	1.079	8.65	11.89	125.5
2	23	141	1.004	143.2	1.081	7.79	11.16	132.04
3	22	184	1.001	198.8	1.079	8.68	17.27	181.53
4	20	125	1.01	126	1.085	6.17	7.78	118.22
5	22	157	1.016	165	1.082	7.19	11.87	153.13
6	21	165	1.012	178	1.07	8.49	15.11	162.88
7	19	157	1.02	171.8	1.082	7.31	12.56	159.23
8	23	125	1.017	126	1.085	6.38	8.04	117.95
9	23	197	1.019	201.1	1.077	9.35	18.79	182.3
10	20	141	1.01	150.8	1.082	10.98	10.98	139.8

Note: Desired weight class is the lowest allowable weight class the wrestler was certified at.

Table 4. Second Data collection (01/09/2015)

Participant	Age (years)	Weight class wrestled (lbs)	Specific Gravity	Weight (lbs.)	Body Density (g/cm^3)	% Body Fat	Fat Mass (lbs.)	Lean Mass (lbs.)
1	21	133	1.028	132.6	1.087	5.28	7.009	125.600
2	23	141		140.6	1.083	7.12	10.020	130.6
3	22	184	1.036	182.6	1.085	6.13	11.189	171.410
4	20	125	1.000	123.2	1.088	4.54	5.600	117.6
5	22	157	1.030	156.6	1.089	4.58	7.180	149.400
6	21	165	1.024	164.2	1.088	4.69	7.710	156.49
7	19	174		164.0	1.089	4.28	7.040	156.030
8	23	125	1.030	124.8	1.086	5.74	7.170	117.630
9	23	197	1.034	196.6	1.079	8.42	16.560	180.040

Note: The specific gravity missing data points are two wrestlers that were unable to produce a sample at the time of testing due to being dehydrated.

Note: Weight class wrestled is the weight class the wrestler competed at on the actual testing date.

Table 5. Final Data Collection (02/13/2015)

Participant	Age (years)	Weight class wrestled (lbs)	Specific Gravity	Weight (lbs.)	Body Density (g/cm^3)	% Body Fat	Fat Mass (lbs.)	Lean Mass (lbs.)
1	21	133	1.036	132.6	1.088	4.75	6.3	126.29
3	22	184	1.026	179.8	1.087	5.54	9.8	169.997
8	23	125	1.038	124.6	1.086	5.42	6.75	117.84
9	23	197	1.036	196.3	1.080	7.96	15.62	180.67
10	20	141	1.021	144.0	1.084	6.65	10.03	140.76

Note: Weight class wrestled is the weight class the wrestler competed at on the actual testing date.

Appendix E

Figure 1. Individual participant's change in fat mass over time

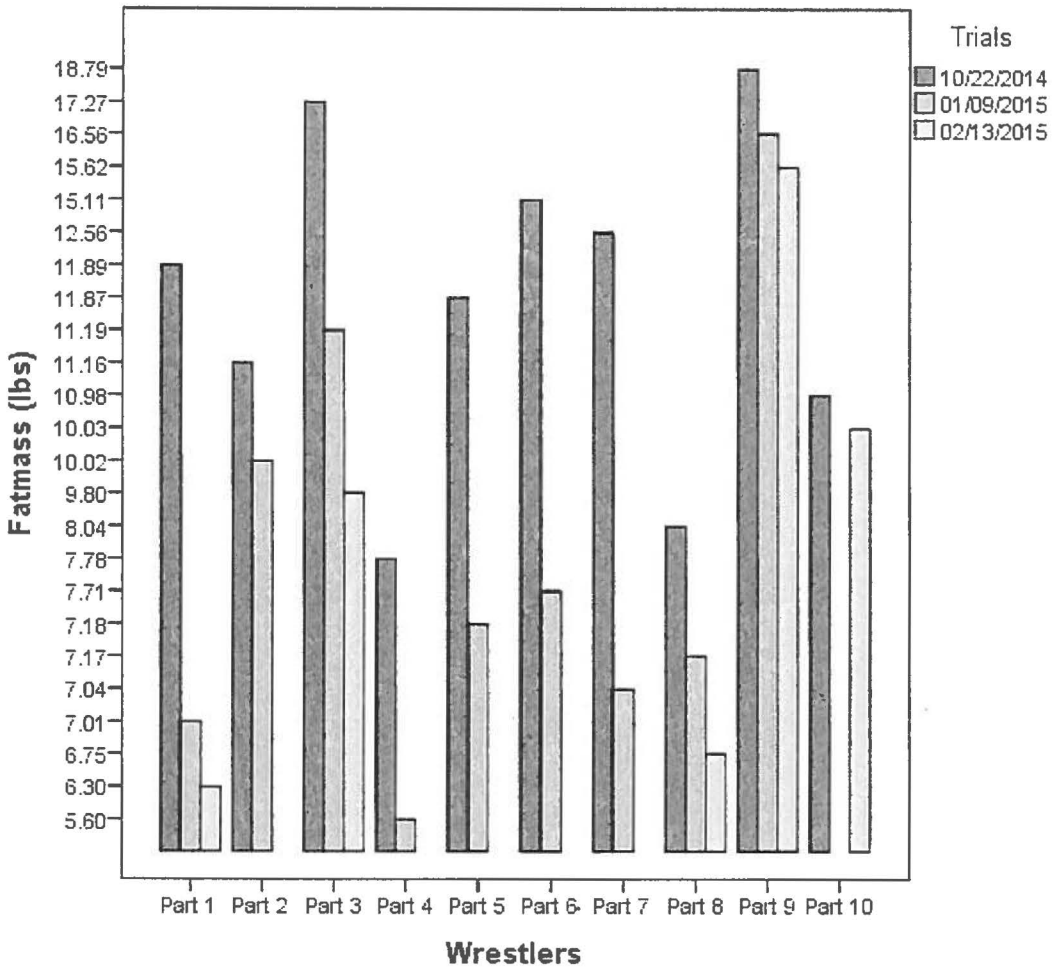


Figure 2. Individual participant's change in lean mass over time

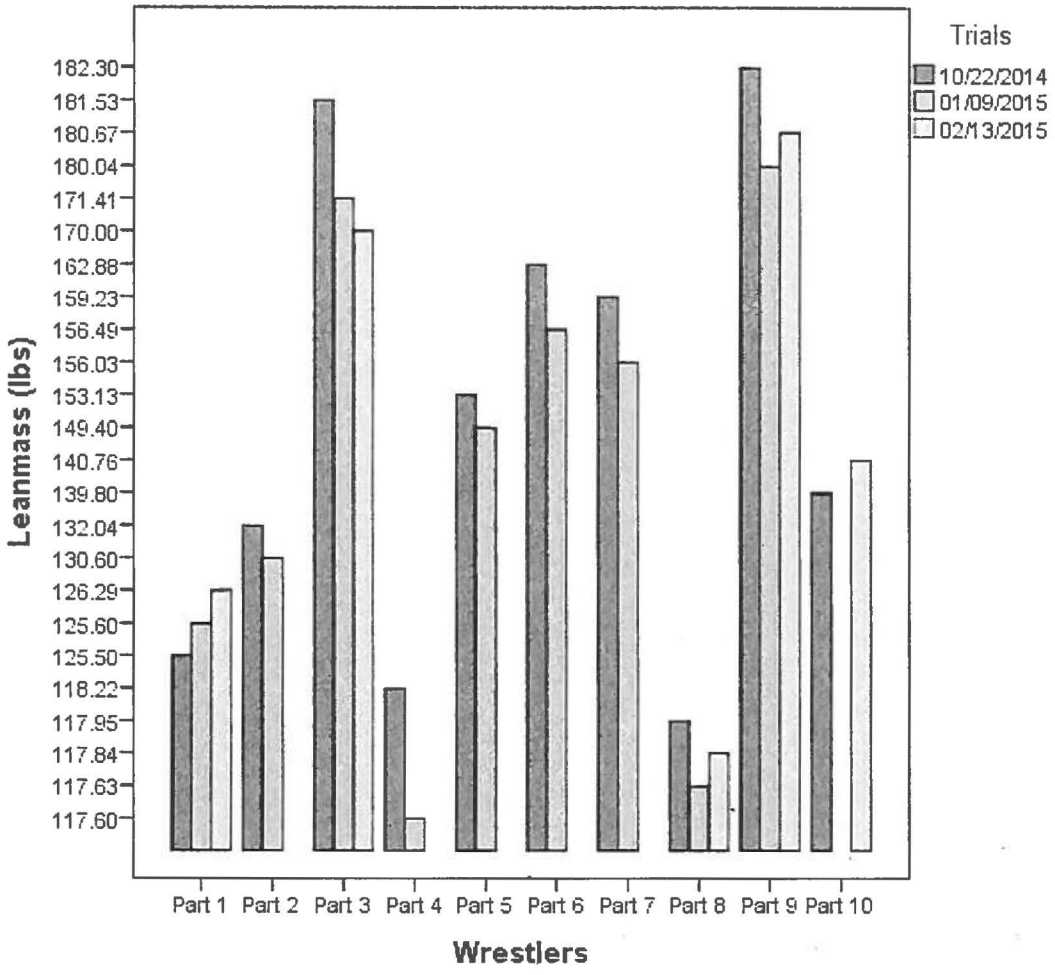


Figure 3. Individual participant's body fat percentage over time

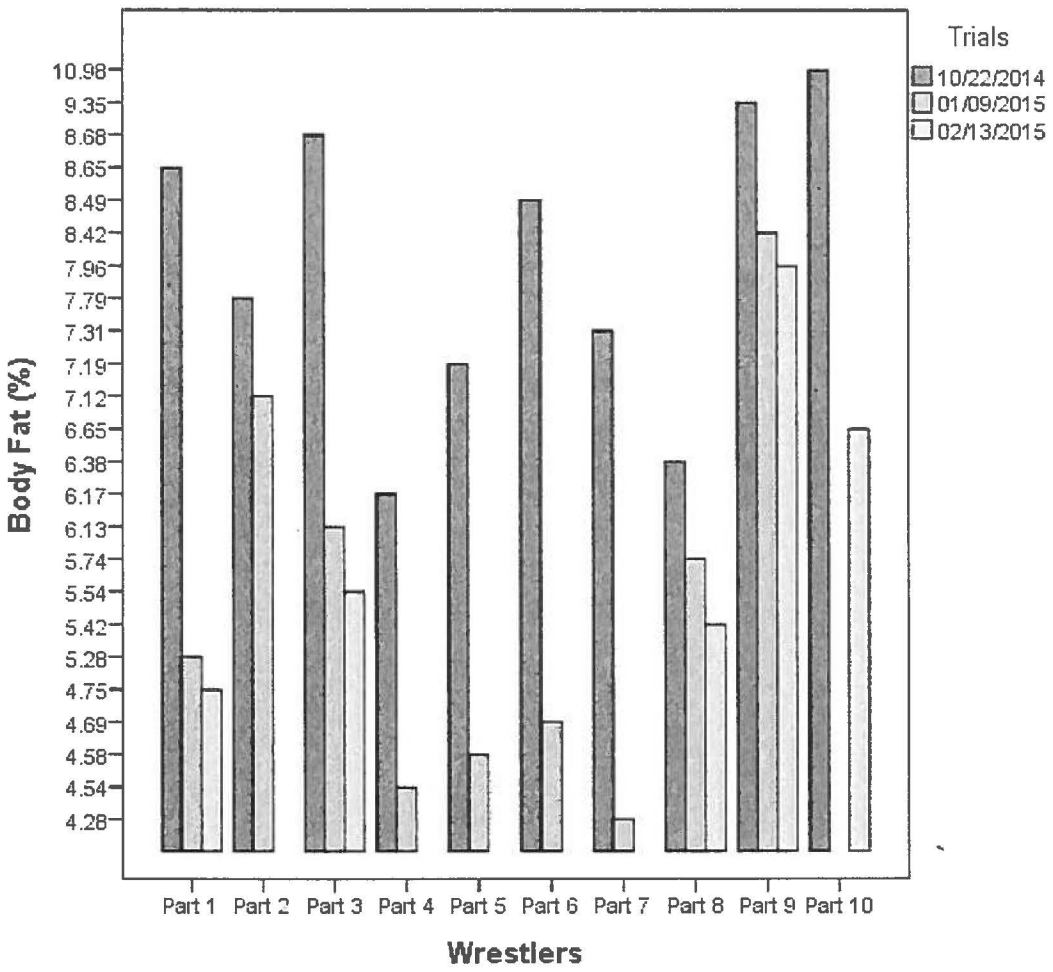
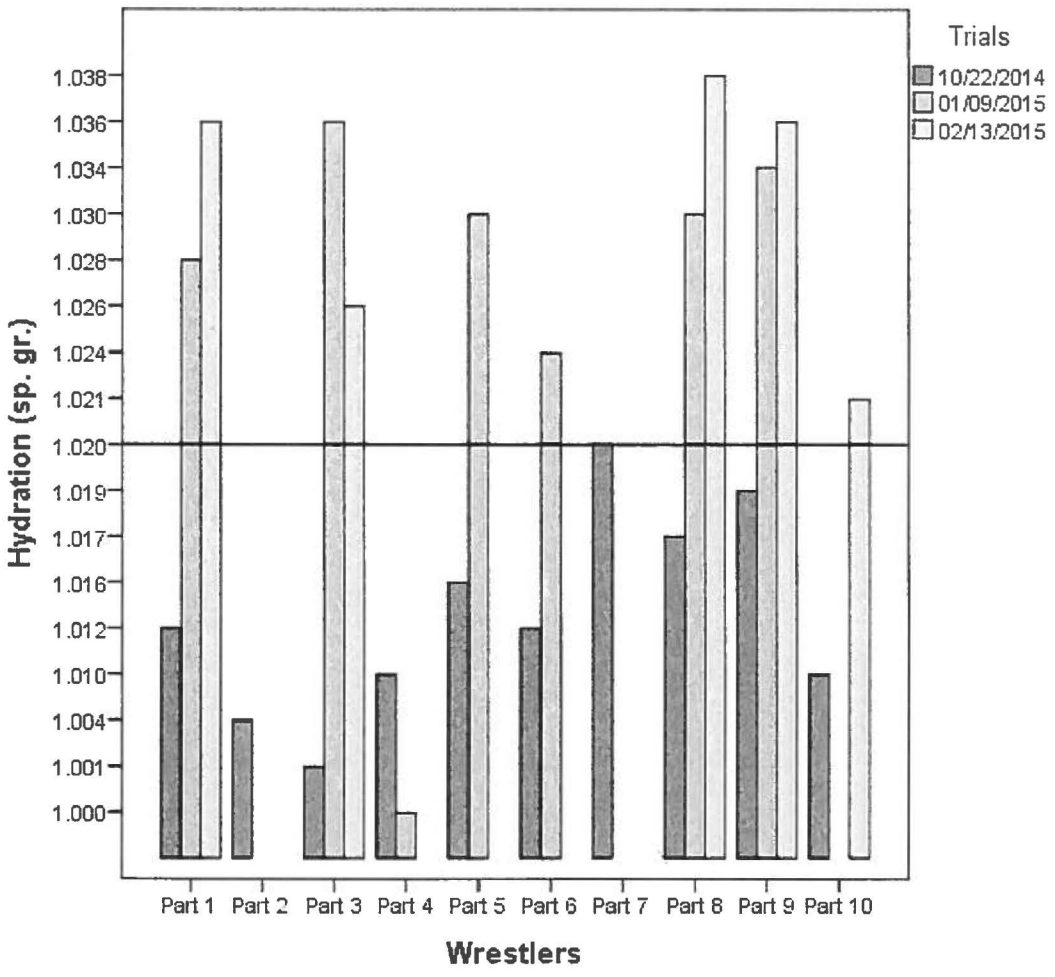


Figure 4. Hydration Status



Appendix F

Table 6. Fat mass and lean mass paired samples t-test (Initial, 10/22/14 and 2nd, 01/09/15)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	fatmass_pre_mid	3.8880	9	2.33886	.77962
	leanmass_pre_mid	3.1089	9	3.31833	1.10611

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	fatmass_pre_mid - leanmass_pre_mid	.77911	2.39301	.79767	-1.06032	2.61854	.977	8	.357

Table 7. Fat mass and lean mass paired samples t-test (Initial, 10/22/14 and Final, 02/13/15)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	fatmass_pre_last	3.6940	5	2.80341	1.25372
	leanmass_pre_Post	2.3041	5	5.25878	2.35180

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	fatmass_pre_last - leanmass_pre_Post	1.38994	3.70617	1.65745	-3.21188	5.99176	.839	4	.449

Appendix G

Table 8. Weekly weigh-ins

Name	22- Oct *	29-Oct	5-Nov	12-Nov	19-Nov	26-Nov	3-Dec	10-Dec
Participant 1	137.4	136.2	132.8	132.7	132.5	132.0	136.2	139.0
Participant 2	143.2	144.0	144.0	140.3	140.0	139.9	140.0	147.0
Participant 3	198.8	194.4	187.0	183.3	183.2	183.0	190.1	187.3
Participant 4	126.0	126.0	124.2	124.3	124.5	123.0	131.0	128.0
Participant 5	165.0	166.2	166.0	156.3	156.0	156.9	156.4	163.0
Participant 6	178.0	174.5	164.0	166.0	165.2	164.2	171.3	168.2
Participant 7	171.8	166.0	157.2	160.3	156.8	157.0	157.6	160.0
Participant 8	126.0	126.2	134.5	130.2	127.5	124.3	124.5	131.0
Participant 9	201.1	201.5	202.0	196.5	196.6	196.7	203.0	199.0

	17-Dec	31-Dec	07- Jan *	14-Jan	21-Jan	28-Jan	4-Feb	11- Feb *	18-Feb
Participant 1	132.1	132.5	132.6	132.6	132.0	131.8	132.8	132.6	132.6
Participant 2	144.0	142.0	140.7	140.6	132.6	140.6	140.1	140.5	140.6
Participant 3	182.2	187.0	182.6	182.6	182.6	183.2	183.5	179.8	183.4
Participant 4	182.0	128.0	123.2	123.1	124.0	123.9	126.0	123.1	123.0
Participant 5	182.0	156.0	156.6	156.6	155.0	156.6	156.7	156.5	155.9
Participant 6	182.0	167.0	164.2	164.9	163.9	169.5	164.1	164.4	163.5
Participant 7	182.0	159.0	160.2	158.6	164.7	164.8	163.8	164.3	164.7
Participant 8	182.0	123.2	124.8	124.6	124.8	124.7	124.3	124.6	123.5
Participant 9	182.0	196.8	196.6	196.7	196.8	196.5	196.7	196.3	196.4

Note: All weights are recorded in pounds (lbs)

*Weekly weigh-in dates that correspond with the hydration/body mass test dates; 10/22/2014, 01/09/2015, 02/13/2015.