Magnitude and Prevalence of Rapid Weight Loss Methods among Male NCAA Collegiate Wrestlers

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It has been well documented that wrestlers and other combat sport athletes utilize weight loss mechanisms to compete in a desired weight class. Following the 1997 NCAA wrestling season, after three student athletes died from excessive weight loss complications, the NCAA implemented a weight management program to combat rapid weight loss methods. In the years following, researchers discovered potential improvements in weight loss and gain within NCAA wrestlers, however, the current methods utilized by collegiate wrestlers have not been well studied in recent years. The purpose of this study was to investigate the prevalence and magnitude of rapid weight loss techniques among male NCAA wrestlers. A total of 63 NCAA wrestlers from four universities participated in the study, with an average age of 20.29 ± 1.63, and 52 of the 63 reported utilizing rapid weight loss methods to make weight for competition during the 2021-2022 wrestling season, resulting in for a prevalence rate of 82.5%. The most used methods were increased exercise (96.2%), gradual dieting (94.2%), food and fluid restriction (90.4%), heated wrestling rooms (80.8%), and fasting (71.2%). Close to a third of subjects (32.7%) reduced their weight 20 times or more in the season and almost all the subjects (90.4%) lost an average of 5-14 pounds and began their weight cut 2-7 days before competition. Wrestlers reported that the individuals who exerted the greatest influence on the wrestlers' methodologies were coaches and fellow wrestlers on their team and individuals while individuals with related educational backgrounds, such as athletic trainers, nutritionists and physicians had little to no influence. The present study was limited by

the survey and the smaller sample size; accordingly, further research should continue through assessing the weight loss methods within a larger population.

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1.0 Introduction

Combat sports such as mixed martial arts (MMA), boxing, wrestling, karate, judo, taekwondo and others, group athletes according to body weight. Frequently, the athletes who participate in these sports with weight classes will intentionally lose body mass to compete at the lowest weight class possible. These athletes often believe the intentional loss will result in gaining an advantage over their competitor. To achieve the desirable weight, the athletes will often incorporate different forms of "weight cutting" strategies. These methods are categorized as either gradual weight loss or rapid weight loss. Gradual weight loss methods are extended over several weeks or months and revolve around the idea of altering both fat mass and fat-free mass through dieting and exercise to induce weight changes. Rapid weight loss or acute mechanisms are utilized within a week or days before competition, and these are the techniques that have gained many concerns over the years due to the harmful effects often associated with using these strategies. Although these methods also include dieting and exercise, rapid weight loss (RWL) strategies tend to center primarily on tactics that are cautioned by medical professionals such as complete cessation of fluid/food intake, thermally stressful conditions (saunas, sweat suits, etc.) and drug use (laxatives, diuretics, etc.). During the 1997 NCAA wrestling season, three collegiate wrestlers died due to complications from excessive acute weight loss. To address this problem, the NCAA introduced a Wrestling Weight Certification Program to combat the magnitude and prevalence of weight loss in collegiate wrestlers.[1] Although there were improvements of weight loss seen in wrestling in the years following the implementation of the WWCP,[2-5] wrestlers and other combat sport athletes continue to engage in these practices due to the pressures and influences of the sport.

1.1 Influences of Rapid Weight Loss Usage

Rapid weight loss (RWL) has been observed in wrestlers as early as the 1930s.[6] Today, there are a multitude of sports that involve weight classes, and thus, the perceived need to manage and maintain body mass has continued. Each sport has its own rules and regulations that predispose the amount of weight athletes can reduce before weighing in and subsequently replenish themselves in the timeframe prior to competition. In addition to the specific rules of each sport, coaches, teammates, other athletes in the sport and parents tend to be the most influential individuals that impact the types of RWL methods an athlete uses, whereas physicians, athletic trainers, and dieticians have little to no influence.[7-14] Notwithstanding sources of influence, it has been considered that weight making practices are rooted within the culture and can be viewed as tradition in these sports.[15, 16]

The primary rules of these sports that govern the RWL techniques include: the number of times the athlete needs to make weight in a season; the number of weight classes the sport has; and the period between the official weigh-in and competition.[17] Collegiate and high school wrestling seasons have competitions on a weekly basis resulting in repeated fluctuations in body mass for those cutting weight.[18, 19] However, other sports such as professional boxing and MMA typically have extended periods separating competitions, which may result in weight reductions only a few times a year, but this may increase the magnitude of weight lost.[20, 21] Furthermore, weight categories for each sport differ, and even more challenging, weight categories can change within the sport based on the specific competition venue. For example, freestyle and Greco-Roman wrestling each has ten weight classes for males and females at most competitions under the United World Wrestling (UWW) but has only six each during the Olympic games and their qualifying tournaments.[22] Lastly, the duration of time given to athletes after the official weigh-in and

competition differs among sports. Some sports, including professional boxing and MMA, have a considerable time of up to 32 hours from weigh-in to competition, allowing athletes to replenish their energy and fluid intake almost completely.[20, 21] Other athletes such as collegiate and high school wrestlers have a more limited timeframe of only ~2 hours for recovery,[18, 19] while some have further implemented random re-weighs that stipulate wrestlers cannot exceed >5% of their initial weight to preclude acute weight gain that can be seen after official weigh-ins.[23, 24]

1.2 Prevalence and Magnitude of Rapid Weight Loss Usage

The prevalence of RWL methods throughout combat sports has varied results between individual studies and sports. However, research estimates that 60-100% of combat athletes engage in some form of weight-cutting mechanism. A recent study by Barley et al., examined the weight loss methods of 637 athletes participating in wrestling, MMA, Brazilian Jiu Jitsu (BJJ), judo, Muay Thai/Kickboxing (MT/K), boxing, and taekwondo from around the world; finding over 85% of participants used body weight manipulation for competition.[8] Reale et al. observed similar results, obtaining an 88% prevalence rate in elite Australian combat athletes participating in Olympic tournaments for judo, boxing, taekwondo, and wrestling.[14] Additionally, some researchers discovered ~90% of judo athletes lost body mass rapidly to make the desired weight class.[7] Results from another study indicate that the specific sport an athlete participates in may impact rates of RWL given that over 97% of MMA athletes engaged in some form of body mass reduction for competition.[10] Furthermore, 96% of athletes competing in taekwondo and wrestling reported RWL use.[9] Conversely, findings from a study assessing body mass reduction methods in karate,

taekwondo, judo, and jujitsu, suggest that decreasing body mass prior to competition may not be as prevalent as believed with rates of 70.8%, 63.3%, 62.8%, and 56.8%, respectively.[25]

Wrestling is recognized as one of the most studied combat sports in terms of weight loss techniques with reports beginning in the late 1930's of wrestlers using these methods to compete in lighter weight classes.[6] Similarly to the other combat sports, research shows that between 60-80% of high school, collegiate and international wrestlers within the United States (US) participate in some form of RWL to reduce their weight prior to competition.[12, 26-28] Steen and Brownell discovered that 89% of college wrestlers and 68% of high school wrestlers responded they were required to cut weight to compete at their desired weight class.[26] Authors reported 84% of college wrestlers engaged in weight cutting prior to competition.[12] In a study involving only high school wrestlers, similar results were captured with 72% of wrestlers stating they used at least one RWL method to lose weight for competition.[27]

Studies involving athletes from countries outside the US have found similar statistics to be prevalent. One author detected that 85.2% of elite wrestlers engaged in RWL techniques before weigh-in from 16 countries competing in the World Wrestling Championships in Belgrade, Serbia.[13] Another study involving male wrestlers in various clubs throughout Tehran, Iran found 75% of athletes used a weight loss method for competition prior to the study and 62% lost weight for competition within the last year.[11]

In terms of assessing the magnitude of RWL in combat sports, one can look at multiple parameters: the amount of body mass the athlete loses for competition, the amount of time weight loss is carried out for, and the amount of times weight reductions are done in a season. The number of weight reductions completed in a single season have ranged from as low as zero and as high as 60; however, ranges typically sit within the 5-15 zone.[7, 8, 12, 14, 26] A study found that wrestlers

reduced their weight at an average of 16 ± 18 times within the last two years, which was significantly more than those athletes competing in BJJ, boxing, MMA, MT/K, and taekwondo, with those averages ranging between three-seven times.[8] These results may be attributed to the higher frequency of 1competitions within the wrestling season. Additionally, a significant difference was found between collegiate freshman (11.9 ± 10.8 times) and upperclassman (7.2 ± 7.6 times) in the frequency of weight cutting.[12] It is important to note that every sport has a unique competition season and regulations that influence the athlete's weight reduction practices.

The physical amount of body mass lost for competition typically ranges between 2-10% of the athlete's body mass.[8, 9, 11-14, 25, 27-29] Similar results have been noted regardless of sex as one study found wrestlers reduced ~3.9 kg (men) and 3 kg (women) for weigh-ins.[13] Of further note, a similar average weight loss was discovered within a collegiate wrestling cohort (4.4 ± 2.1 kg) compared to that of a high school sample (3.3 ± 1.8 kg).[26] The average amount of weight loss may also be dependent upon the sport as one study noticed an average weight loss of 6% between the BJJ, boxing, judo, MT/K, TKD and wrestling competitors with a significantly higher average of 11.5% in MMA athletes.[8] Additionally, research detected an average weight loss of 8.4 kg (10.1 %) in professional and 6.4 kg (8%) in amateur male MMA athletes; the female professional MMA athletes lost an average of 5.5 kg (8.6%), with the amateur females losing 4.8 kg (7.2%).[10] Conversely, a study found the average weight loss to be only 1.6 ± 1.6 kg (2.5 ± 2.3 %) within judo competitors.[7]

Another factor of consideration is the number of days used to complete the weight cutting process has, which has also differed radically. Typically, the more weight an athlete must lose, the longer the timeframe it will take; however, if the number of times an athlete is required to perform the weight reductions for competition in a season is higher, it may decrease the amount of weight

loss that can be attained. Wrestlers engage in many competitions per year, which gives them limited time to reduce weight, and as a result, these athletes reduce weight in only 5-10 days,[8, 9, 11, 13, 26] with one report determining that wrestlers had a statistically lower average of 7 ± 9 days than all other combat sports including BJJ (18 ± 19 days), boxing (26 ± 26 days), judo (14 ± 16 days), MMA (27 ± 24 days), MT/K (21 ± 20 days), and TKD (28 ± 48 days).[8] Another study found a 17-day average of weight reduction within a group of taekwondo athletes, with an average between 10-12 days for the boxers, judokas, and wrestlers, although no statistical significance was reached.[14] Conversely, another author determined with statistical significance that taekwondo athletes reduced their weight in less days (9.7 ± 5.2) than jiujitsu, judo and karate athletes, and the jujitsu athletes reduced their weight in 21.5 ± 14.4 days, statistically longer than the athletes from the other three sports.[25]

1.3 Types of Rapid Weight Loss

Various types of RWL methods have been documented throughout the literature and can be classified into one of three groups (as defined by the newly published consensus statement, "ACSM Expert Consensus Statement on Weight Loss in Weight-Category Sports"): 1) adjustment of body water, 2) adjustment of glycogen storage, and 3) adjustment of gastrointestinal tract contents.[17]

1.3.1 Body Water Adjustment

Approximately, 60% of the human body is made up of water. Wrestlers and other combat athletes can manipulate the amount of body water to induce weight loss; however, the changes are transient and once the athlete rehydrates themselves, predictably much of the body mass is regained. Manipulating body water through increased exercise or fluid restriction are some of the commonly used methods of weight management due to their relatively easy implementation and quick results. Methods that fall under body water manipulation include passive and active sweating, fluid restriction, water loading, and diuretics.[17]

Active sweating occurs when the athlete actively tries to induce secretions through intense, excessive exercise. This is a primary method of RWL with ~70-95% usage rates seen throughout all combat sports.[7-14, 25, 27, 28] Athletes will sometimes train in heated rooms, a practice that ranged in studies between ~30-65%;[7,-10, 12-14, 27] yet two other studies reported higher rates of this technique with wrestlers at ~75-85%.[8, 9] Passive sweating is a method used to promote bodily secretions without exerting much energy and is typically achieved by sitting in a room with an elevated temperature such as a sauna or steam room to increase secretions. Sauna use varies among sports, and studies show rates from ~10-30%,[7, 12, 27] and up to ~40-80%[8-11, 13, 14, 25, 28] of athletes employing the strategy. One study noticed college wrestlers used this method more frequently (~50%) than high school wrestlers (~20%).[26] Additionally, some athletes may utilize rubber or plastic suits to increase the active or passive sweating mechanism, which is seen with varied rates in wrestlers between ~10-85%.[7-14, 26-28]

Fluid restriction leading up to the days of competition/weigh-in is another common form of body water manipulation. This strategy has extremely varied usage with rates anywhere from ~25-90% of combat athletes engaging in fluid restriction,[7-14, 25-27] although research has found the

highest usage within MMA athletes at 75%,[8, 10] boxers at 70%,[8, 14] and wrestlers between 80-90%.[8,14] In more recent years, a new method termed "water-loading," has increased usage rates specifically within MMA (~65-75%), boxers (65%), MT/K (62%), BJJ (50%) and taekwondo (48%) athletes.[8, 10] This method is achieved by ingesting large amounts of fluid on consecutive days with abrupt fluid restriction one day prior to weigh-in. Another method of body water management banned by the World Anti-Doping Agency is the use of diuretics.[30] Research has shown very low usage rates of this method throughout sports with only 5-15% of users among combat athletes.[7-14, 26, 28] On the contrary however, another article indicated that 35% of athletes from judo, jujitsu, karate, and taekwondo engaged in the use of diuretics.[25] Despite its typically rare usage, diuretics use is the most violated rule seen within combat sports.[31]

1.3.2 Glycogen Storage Adjustment

In addition to the manipulation of body water, management of energy or glycogen stores can be achieved through increased exercise or reduction of energy and/or carbohydrate intake.[17] Glycogen or glucose is the primary energy source for humans, however, if all of the energy generated from food is not used, it may stay in the body and turn into fat mass. Athletes will restrict food intake or increase exercise to help reduce their fat-mass and weight, making management of the energy/glycogen stores in the human body the second most common forms of weight loss methods in combat sport athletes. Comparable to body water management, athletes will also increase exercise to reduce their glycogen stores, in concert with skipping one to two meals a day and/or completely fasting, both of which have high rates of usage in combat athletes, although the number of athletes employing these mechanisms is elevated within those competing in taekwondo

and wrestling. Fasting is used by 55-70% of wrestlers while 70-90% skip meals.[8, 12, 14, 26] Likewise, 60-70% of taekwondo athletes fast and 70-85% skip meals.[8, 14]

1.3.3 Gastrointestinal Tract Content Adjustment

Lastly, gastrointestinal (GI) tract contents are regulated by the cessation of food/fluid intake or bowel movement production.[17] As stated, the restriction of food and fluid is a very common practice used within combat athletes and one approach to alter their GI contents. Unconventional means may also be utilized to increase bowel movement production, such as laxatives, forced vomiting, and enemas, but these are all used with extremely low rates of usage, at 1-10%, 1-5%, and 1%, respectively.[7, 8, 10-12, 14, 26, 27] Some authors have contradicted these statistics and determined ~15-20% of MMA athletes[10] and wrestlers[13] may utilize laxatives for weight loss. Both laxatives and enemas can significantly increase bowel production to help quickly release the contents of the gut, whereas forced vomiting does not directly increase bowel production but quickly removes the gut contents. Nonetheless, although these methods are typically rarely seen within these sports; however, it is important to address them due to the consequences they pose.

1.4 Effects of Rapid Weight Loss

Research shows that RWL methods are not exclusively labeled with negative consequences, but while some may appear beneficial, most evidence points to the contrary. The

effects RWL may have on a subject fall into three subgroups: physical (performance-based), psychological (cognitive), and physiological (markers).

1.4.1 Physical Effects

RWL strategies are typically implemented to compete at the lowest weight class possible conceivably to gain a physical advantage over a smaller opponent. Some research concurs with this concept, as multiple studies have found that those who lost more body mass had more competitive success in tournaments.[28, 32-35] Place winners at an international-style high school wrestling tournament reduced significantly more weight than those who did not place.[28] Furthermore, two studies by the same authors discovered high school wrestlers that competed below the Minimum Wrestling Weight (MWW) of 5% body fat, had greater success at a regional-level wrestling tournament and the magnitude of weight gain was higher in the winners of first-round matches than the losers.[34, 35] Roughly 85% of over 150 combat sport athletes participating in wrestling, taekwondo, and boxing at the Spanish National Championships were severely dehydrated during the official weigh-ins, yet 70 of these athletes were successful in winning a medal.[32] In judo, it was noted that those who received medals and won matches experienced a significantly greater weight gain after the official weigh-in than their non-medalist and losing counterparts.[33]

Other studies have shown that neither an advantage nor a disadvantage may occur in terms of physical performance when using RWL. There were no observed differences in the amount of weight gained 20 hours after the official weigh-in between place winners and non-place winners or those who won and lost their first-round tournament at the NCAA wrestling championships.[36] Another group of authors also detected insignificant differences in post-weigh-in weight gain when

compared to competitive success in eleven wrestlers tracked throughout an entire NCAA wrestling season.[37] In adolescent boxers, RWL was not associated with winning a medal at the European Championships (EC).[38] Similarly in an elite population of boxers competing at the Australian national championships, there was no significant difference in weight gain between official weigh-in and one hour before a competition bout between the winners and losers of individual bouts or the finalists and non-finalists.[39] Furthermore, it was noted that the weight regained after the official weigh-in was not correlated with winning or losing the match.[40] Notably, it is important to consider that both winners and losers regained considerable body mass of 10.1% and 9.1%, respectively.[40]

In addition to real-life competition-based effects of RWL, studies have investigated the lab-based performance effects including those associated with endurance, power, and strength. Conflicting evidence has shown that RWL may not always harm athletes' endurance, aerobically and anaerobically. Typically, researchers find that when athletes are given ~4-5 hours of recovery, there are no impairments found within anaerobic endurance performance.[41-46] One study discovered that chronic weight cyclers presented with similar anaerobic exercise capacity as non-weight cyclers following a 5% loss in body mass and recovery time of four hours, indicating that chronic weight cyclers do not attain adaptations from the effects of rapid mass reduction.[44] Another study determined there are improvements in kicking frequency within simulated taekwondo matches in athletes that rapidly lost 5% of their body weight in approximately three days.[47] Notably, significant decreases have also been observed in combat athletes' anaerobic performance even when a period of recovery was given to the athlete.[48-50] It is important to note that the boxers in one study were only given a two-hour recovery period after weigh-ins; the authors stated that this was typically used as the time frame in amateur boxing championships.[50] Studies involving minimal to no recovery opportunity for athletes tend to find substantial impairments in anaerobic

capacity.[51-54] When comparing the differences of a high intensity isokinetic upper body exercise in collegiate wrestlers, results showed that those in the high-carbohydrate diet group had less reductions in total work performed than the low-carbohydrate diet group.[52] In another setting, however, a group of authors found that neither lower extremity anaerobic power nor isometric grip strength performance was hindered in collegiate wrestlers when no recovery period was given.[55] Likewise, it was found there were no differences in hand gripping strength and endurance between trials performed at no weight loss, a 5% body weight reduction and after a recovery period to return to original weight.[56] Two similar studies to assess the punching power in amateur boxers, found that rapid body mass reduction did not interfere with punching force in simulated boxing bouts of three, 3-minute rounds.[57, 58] Conversely, many researchers have noted impairments in muscular strength and power in combat sport athletes after rapid weight reduction, followed by no recovery time before performance tests were completed.[54, 59-62] Many combat sports allow time between the official weigh-in and competition, enabling the athletes to replenish themselves and mitigate any negative performance effects.

1.4.2 Physiological Effects

In addition to performance-based consequences, there are several physiological effects that are seen in athletes engaging in RWL strategies ranging from fluctuations in hormonal levels, growth impairment, reduced basal metabolic rate and immune system dysfunction. Both acute[53, 63-66] and chronic[67, 68] hormonal imbalances have been seen in athletes engaging in rapid weight loss. Specifically, researchers have found consistent decreases in testosterone and insulin-like growth factor 1 levels within wrestlers during the competition season.[64-68] In addition, when assessing the effect on basal metabolic rate (BMR), articles have seen decreased BMR within the

competitive wrestling season;[69, 70] however, one found no difference between weight cyclers and non-cyclers.[71] There were concerns of potential negative effects to the immune system with findings of reduced markers of function including T-cells, phagocytic activity, and others within weight class athletes, but no correlation to increases in injury or illness have been seen.[72-76] One systematic review analyzed the effects RWL may have on the functioning of the kidneys, concluding that the significant increases within blood urea nitrogen and creatinine levels within combat athletes after RWL may be indicative of acute kidney damage.[77]

Athletes engaging in RWL within days of competition typically prioritize body water manipulation to reduce their weight. Unfortunately, a common bypass of altering one's body water is acute dehydration. Researchers have found that hypohydration reduces blood plasma volume, impeding cardiovascular and thermoregulatory functions.[78-80] Athletes may also experience electrolyte imbalances depending on mode of water reduction, which may lead to weakened neuromuscular function and muscle cramps,[81, 82] but multiple investigations showed dehydration had little effect on neuromuscular function and the fatiguing of muscles.[83-86] Transient changes in magnetic resonance images of the brain have been identified after acute dehydration[87-89] and have been linked to poor visual-motor control[90] and cognitive test performance.[91] Moreover, scores from concussion tests within healthy collegiate wrestlers including the Sports Concussion Assessment Tool 2 (SCAT2), Balance Error Scoring System (BESS) and Graded Symptom Checklist (GSC), were found to be superior in the euhydrated state compared to their scores in the dehydrated state.[92]

In addition to acute dehydration strategies, athletes engaging in reduced food intake increases the risk of harmful effects of low energy availability (LEA) defined as insufficient energy uptake compared to energy output.[93] Like hypohydration, negative effects on performance due to

increased fatigue have been seen due to reduced glycogen storage altering the excitation-contraction coupling within the muscle fibrils.[94] Exposure to LEA many times throughout a season is a widely known contributing factor to the syndrome known as relative energy deficiency in sports (RED-S).[17] First coined in 2014, RED-S is altered functioning of different physiological processes due to relative energy deficiency including impaired immune and endocrine functions, protein synthesis, bone health, metabolism, and others.[93] It has been found that rapid weight reduction elevated bone loss in a cohort of male and female judo athletes by increasing bone resorption relative to formation.[95]

1.4.3 Psychological Effects

With the increasing notion that RWL may be detrimental towards athletes, more evidence is beginning to point out the disadvantages it may bring, specifically the psychological effects. A large concern associated with the use of RWL in athletes is the potential for the development of disordered eating or eating disorders (e.g., anorexia nervosa, bulimia nervosa). In a recent survey-based study, the authors concluded that wrestlers, along with baseball players and cyclists, scored the highest on the Eating Disorder Examination-Questionnaire, indicating eating behaviors concerns.[96] Additionally, in a meta-analysis of 28 studies regarding disordered eating in male athletes, the authors noted that the athlete cohort, specifically wrestlers, had a greater rate of disordered eating when compared to non-athlete controls.[97] One of the more commonly used tests to determine eating behaviors is the Eating Attitude Test (EAT-26) that has been implemented within multiple different studies.[59, 98, 99] Subjects with higher scores is indicative of potentially dangerous eating behaviors that may need to be further addressed. One investigation discovered significantly higher EAT-26 scores within the subjects identified as athletes when compared to

their non-athletic, BMI-matched controls.[59] Research, however, is equivocal and does not always infer that combat sport athletes have a higher risk of obtaining disordered eating. It was determined that there was no significant difference between EAT-26 scores among a group of TKD/judo athletes and non-athletes.[98] Another study observed EAT-26 scores below the "at-risk" mark (≥20) within a cohort of 19 collegiate wrestlers.[99] Notably, the EAT-26 scores were significantly higher during the beginning of the season at maximum weight loss, as well as significantly higher in the female athletes, indicating female combats may have more of a risk than their male counterparts.[99]

Researchers have also investigated the mood/behavioral cognitive changes that may be experienced during RWL. More homogenous findings throughout studies have determined that athletes who employ RWL strategies typically will present with altered mood and behavioral emotions. Within a systematic review on the effects of RWL on judokas (a person who practices judo), it was determined that RWL will negatively impact one's psychological state before competition.[100] Of the studies assessing the psychological effects, all three utilized the Profile of Mood States (POMS) instrument to assess six different categories: tension, depression, anger, fatigue, confusion, and vigor. All three studies noted significant changes in all categories except for depression[59,63] and confusion.[63, 101] Researchers also noticed lower vigor and elevated tension and confusion after a four-week period of weight loss when comparing the experimental group of judokas to the control judokas that did not engage in weight loss.[102] Hall and Lane observed elevated anger, tension, and fatigue levels with reduced vigor in 16 amateur boxers after a weeklong period of weight loss between training and competition weight.[50]

Choma et al. uncovered a significant difference in the mood state categories of tension, depression, anger, fatigue, and confusion within a cohort of collegiate wrestlers when compared to off-season collegiate athletes.[103] These results were supported by the findings of Landers et al.,

comparing the mood states of a group of wrestlers undergoing RWL with a group that was not.[104] Additionally, 16 male collegiate wrestlers presented with significant differences in anger, depression, and vigor over a ten-day span of weight loss before competition.[55] The same researchers discovered the magnitude of weight loss positively correlated with the change in confusion and tension between testing periods.[55] Significant increased levels of tension, depression, anger, fatigue, and confusion and decreased vigor after a four-day period of weight loss were found in twelve collegiate wrestlers.[51] Although many negative consequences of mood have been noted, some authors have found no significant change in behavioral and psychological performance within combat sport athletes following acute weight loss.[41]

Very little research has found positive outcomes regarding mood and psychological well-being after RWL. However, one study documented the beneficial aspects of weight regulation that includes: providing a sport-identity of belonging, reputation, and professionalism; behaves as a mental distraction that helps rectify focus, self-control, and dedication to the sport; and lastly, can provide a mental advantage over their opponent through self-confidence and perception of power/size.[16]

1.5 Methodology

Multiple studies have been conducted to examine the RWL methods within wrestlers. Steen and Brownell first created their questionnaire to assess RWL in high school and collegiate wrestlers.[26] Kiningham et al. next reviewed RWL techniques in high school wrestlers that utilized their own two-page survey with some questions modified from a previous study.[27, 105] Another study examined the RWL of high school wrestlers competing in an international-style tournament

employed a survey that was adapted from studies done by Kiningham et al. and Steen and Brownell.[26-28] The study by Oppliger et al. that explores RWL methods in collegiate wrestlers was formed with influence from three previous articles.[12, 26, 106, 107] A researcher utilized these notable investigations to create a reliable questionnaire to assess RWL patterns in judo athletes.[108] This validated survey was approved by ten experts before publication and has been adjusted for use in almost all weight-category combat sports.[7-11, 13, 14, 25]

1.6 Problem Statement

During the 1997 NCAA collegiate wrestling season, three wrestlers died from acute dehydration due to complications from RWL. In the year following, the NCAA introduced the Wrestling Weight Certification Program that included six new rules with the intention to reduce the prevalence of RWL in collegiate wrestlers.[1] Some success was observed within the following years, such as less seasonal fluctuations in body mass index[2, 5] and a reduction in weight gain after the official weigh-in and before competition within NCAA national qualifiers;[3, 4] however, it is widely known wrestlers continue to purposefully reduce their weight. In recent years, combat sports such as MMA and judo that have been intensely studied that primarily contain athletes outside the United States[7-11, 13, 14] and master's theses have investigated collegiate wrestlers for individual teams,[109, 110] but, the practice among all NCAA wrestlers has not been established for almost ten years,[111] also a master's thesis.

1.7 Purpose

The purpose of this study is to investigate the prevalence and magnitude of rapid weight loss techniques among male NCAA collegiate wrestlers.

1.8 Specific Aims

Specific Aim 1: To examine the prevalence of rapid weight loss methods among NCAA collegiate wrestlers from the 2021-2022 wrestling season.

Specific Aim 2: To examine the specific types of rapid weight loss methods used by NCAA collegiate wrestlers from the 2021-2022 wrestling season.

Specific Aim 3: To examine the frequency of weight fluctuations among NCAA collegiate wrestlers from the 2021-2022 wrestling season.

Specific Aim 4: To examine the duration of time rapid weight loss takes place prior to competition among NCAA collegiate wrestlers from the 2021-2022 wrestling season.

Specific Aim 5: To examine the targeted magnitude of rapid weight lost prior to competition among NCAA collegiate wrestlers from the 2021-2022 wrestling season.

Specific Aim 6: To examine the influences of weight loss methods used by NCAA collegiate wrestlers from the 2021-2022 season.

Specific Aim 7: To describe the relationship between competitive wrestling history and the rapid weight loss practices of NCAA collegiate wrestlers.

1.9 Study Significance

Due to the expectations and rooted cultures of these combat sports, wrestlers and other combat athletes will likely continue to engage in some form of weight loss or management strategies to compete at a certain weight class for competition. Despite this, some researchers are seeking that weight cutting should be banned outright such as with doping.[112] Clinicians and sport organizations are aware that methods promoting dehydration and low energy have harmful effects, however, many athletes continue to use them. To combat the fluctuating habits of weight loss within these athletes, athletic trainers, and other sports medicine professionals such as nutritionists must understand what methods are being used and the magnitude of weight loss. Additionally, improvements or modifications in the rules and regulations may help change the culture surrounding weight loss, thereby decreasing usage.

2.0 Methodology

2.1 Experimental Design

This was a descriptive, normative study investigating the rapid weight loss methods used by NCAA collegiate wrestlers. An online survey was introduced to four NCAA institutions in western Pennsylvania and the surrounding areas that sponsor a wrestling team. The survey consisted of 19 questions throughout four sections: 1) student demographics; 2) competitive wrestling history; 3) weight loss history; and 4) the methods and influences of weight loss. The survey took approximately 5 minutes to complete and could be accessed through any mobile device.

2.2 Subject Recruitment

Subjects were recruited by contacting NCAA institutions sponsoring a wrestling program in western Pennsylvania and the surrounding areas. To recruit wrestlers, an e-mail was first sent out to the athletic trainers working with the wrestling teams detailing the study and asking for their participation. It also requested the primary investigator's ability to introduce the study with the wrestling team members and ask for their participation to complete the weight loss survey. If the athletic trainer and coaches agreed to allow the primary investigator to meet with the team, a time was established by the PI and athletic trainer that suited everyone. After the primary investigator introduced the study in person, sheets of paper with a QR code were shown in front of the athletes

that they could scan with their mobile device and be directed to the Qualtrics survey. Prior to completing the survey, the student athlete gave consent to participate in the study and was assured that all results will remain anonymous.

2.3 Subject Characteristics

2.3.1 Inclusion Criteria

- Any athlete on a NCAA wrestling team roster for the 2022-2023 season
- Athlete must have been active in competition from the 2021-2022 season

2.3.2 Exclusion Criteria

- Athletes that did not participate in competition from the 2021-2022 season

2.4 Power Analysis

To date there have been multiple studies assessing weight loss methods in combat sport athletes, and specifically, wrestlers. Of those studies, the number of subjects included within the research design have ranged from roughly 50 subjects to over a thousand recruited subjects.[12, 26-28] In order to collect the highest response rate, the primary investigator elected to have an in-person meeting with each recruited wrestling team and collect survey responses during the meeting. The primary investigator reached out to five NCAA institutions that sponsor a wrestling team in

western Pennsylvania and the surrounding areas. An NCAA wrestling team typically has roughly 30 members, thus the estimated number of subjects that will be recruited is 100. The study allowed every subject who volunteered to participate to obtain the maximal number of responses.

2.5 Instrumentation

2.5.1 Qualtrics Online Survey System

The study utilized a Qualtrics survey with questions modeled from previous studies to assess RWL methods in wrestlers. Qualtrics Survey Software is a platform system used by the University of Pittsburgh to organize and distribute surveys. The survey was comprised of four different sections, with 19 total questions. The first section included questions pertaining to the student athletes' demographic information, such as current year in school, age, height, weight, and weight class. The second section pertained to the competitive wrestling history of the athletes. The third section was related to each athletes' weight loss history. The final section regarded the specific methods used to reduce weight and the influences of the mechanisms utilized.

2.6 Procedures

2.6.1 Data Collection

First, the primary investigator sent an email to the wrestling team's Athletic Trainer with a brief description of the study. The primary investigator then met with the wrestling team to

introduce the study to the student athletes. After introducing the study, the primary investigator showed a piece of paper with a QR code that the student athletes scanned with the mobile device and completed the survey. Subject participation was completely voluntary. Data was collected and recorded through the Qualtrics Survey System.

2.7 Data Reduction

Data was collected via Qualtrics Core XM Online Survey System (Qualtrics XM, Provo UT, USA). Any response that indicated the student athlete did not participate in competition from the previous season was excluded from the analysis.

2.8 Data Analysis

Descriptive statistics (mean, standard deviation, median, interquartile range, proportion, as appropriate) were calculated for all variables. Absolute and relative frequencies were utilized to describe data about rapid weight loss practices. Prevalence was calculated as the percentage of athletes in the study who participated in any rapid weight loss methods during the 2021-2022 season. Categorical data was compared between groups using Fisher's exact tests as appropriate. Statistical analysis was conducted using IBM SPSS Statistics (IBM Corp, Armonk NY, USA). Statistical significance was set *a priori* at alpha = 0.05, two-sided.

3.0 Results

The data collection period for this study lasted four weeks, resulting in a total of 65 survey responses. Of those 65, one subject did not consent to the study's terms, and another did not meet the inclusion criteria for participation. This resulted in a total of 63 survey responses. The results of those survey responses are listed below.

3.1 Subject Demographics

The first section of the survey included questions about the subjects' demographics. The subjects' age, height and current weight results are displayed in Table 1.

Table 1 Subject Demographics: Age, Current Weight, Height

	n	Mean ± SD	Range
Age (in years)	63	20.29 ± 1.63	18-25
Current Weight in lb. (kg)	62*	166.34 ± 21.53 lb. (75.45 ± 9.77 kg)	130-225 lb. (58.97-102.06 kg)
Height in in. (cm)	63	69.44 ± 2.70 in. (176.37 ± 6.86 cm)	63-76 in. (160.02-193.04 cm)

n = number of subjects, *One study participant did not answer this question

3.1.1 NCAA Division

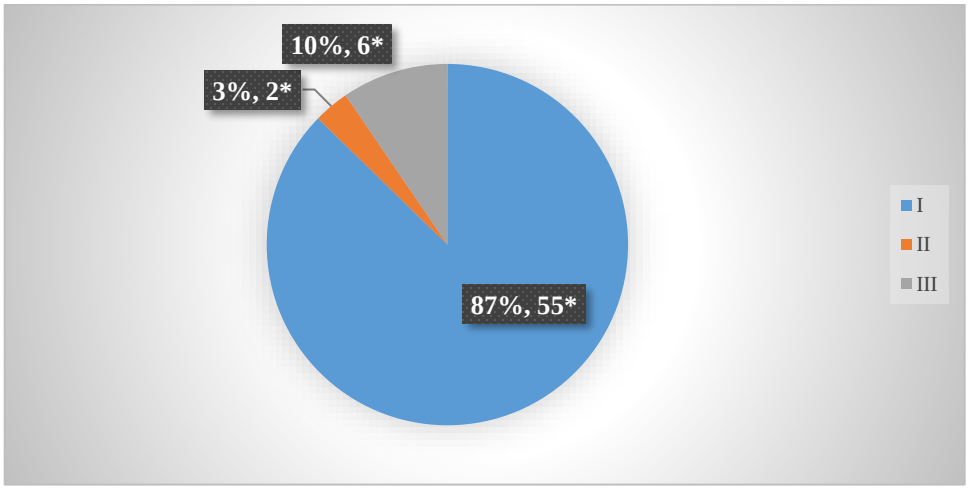

Figure 1 NCAA Division (n = 63)

Figure 1 represents the NCAA Division in which the athlete currently competes in. Most of the subjects (87%, n = 55) competed in Division 1. *Data labels are represented as both counts of individuals and percentages.

3.1.2 Level of Study

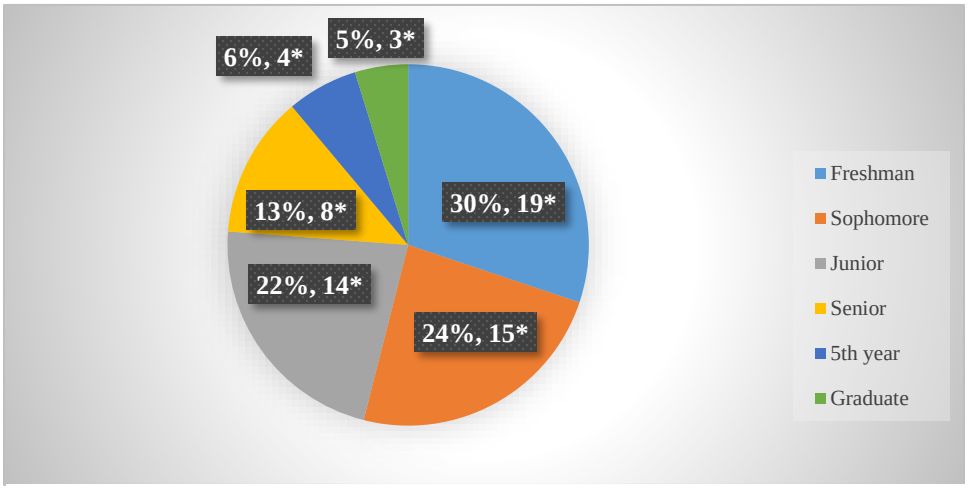

Figure 2 Level of Study (n = 63)

Figure 2 represents subjects' level of study. More than three quarters of the subjects (76%, n = 48) identified as a freshman, sophomore, or junior. *Data labels are represented as both counts of individuals and percentages.

3.1.3 2022-2023 Weight Class

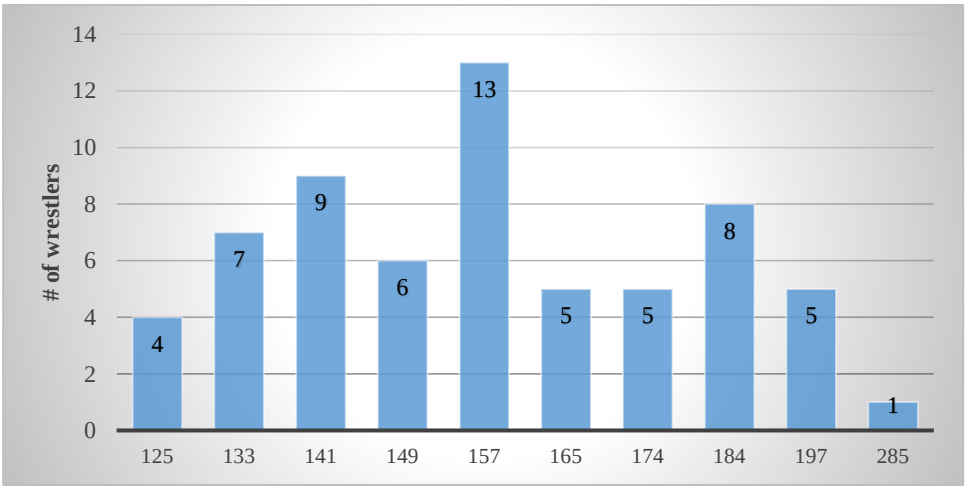

Figure 3 Weight Class (in pounds) for 2022-2023 Wrestling Season (n = 63)

Figure 3 represents subjects' estimated weight class for the 2022-2023 NCAA wrestling season. The 157 lb. (20.6%, n = 13) weight class was the highest reported weight class, followed by 141 lb. (14.3%, n = 9) and 184 lb. (9.5%, n = 8).

3.2 Competitive Wrestling History

The second section of the survey included questions about their competitive wrestling history regarding the 2021-2022 wrestling season.

3.2.1 2021-2022 Wrestling Status

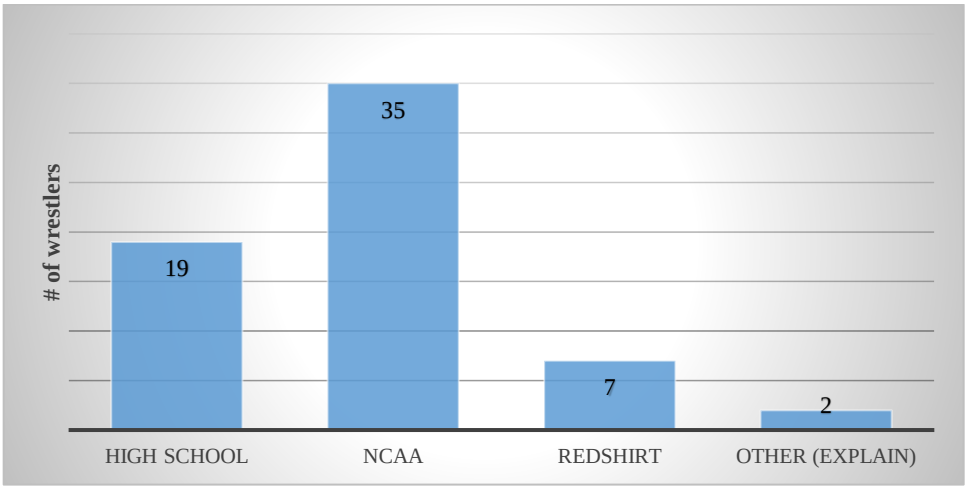

Figure 4 Subjects' Wrestling Status for 2021-2022 Wrestling Season (n = 63)

Subjects were asked to identify their wrestling status for the 2021-2022 wrestling season. The options were high school, NCAA, redshirt and other. Redshirt was an included option because the NCAA allows wrestling student athletes to compete in "unattached" matches or tournaments without losing a year of athletic eligibility. Figure 4 shows the subjects' wrestling status and most selected NCAA (55.6%, n = 35) or high school (30.2%, n = 19). The two individuals that chose other sustained an injury mid-way through the season.

3.2.2 2021-2022 Wrestling Accomplishments

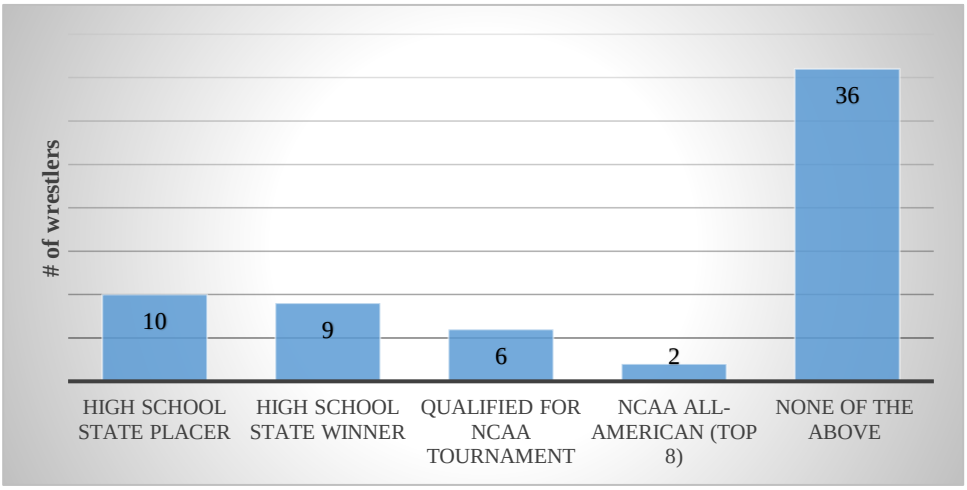

Figure 5 Subject's Wrestling Accomplishments for 2021-2022 Wrestling Season (n = 63)

Subjects were asked to identify what best describes their wrestling accomplishments for the 2021-2022 wrestling season. The choices included NCAA All-American, qualified for NCAA tournament, high school state placer or winner, and none of the above. Figure 5 represents subjects' wrestling accomplishments with over half answering none of the above (57.1%, n = 36).

3.3 Weight Loss History

The third section of the survey included questions about their weight loss history regarding the 2021-2022 wrestling season.

3.3.1 2021-2022 Weight Class

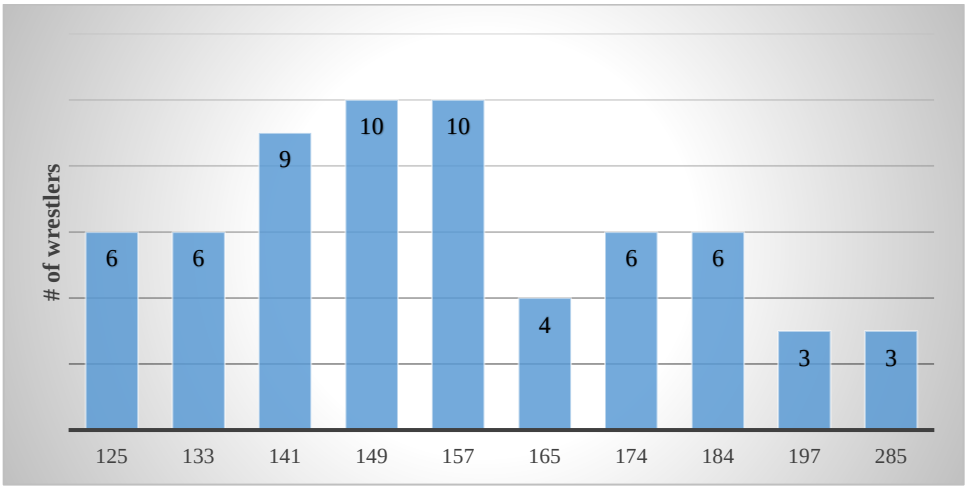

Figure 6 Subject's Weight Class (in pounds) for 2021-2022 Wrestling Season (n = 63)

Subjects were asked to pick the weight class that best described them for the 2021-2022 wrestling season. Figure 6 represents subjects' weight class for the 2021-2022 NCAA wrestling season. The 157 lb. and 149 lb. (15.9%, n = 10) were the highest reported weight classes, followed by 141 lb. (14.3%, n = 9).

3.3.2 Weight Loss Prevalence

Of the 63 study participants, 52 (82.5%) reported they cut weight for competition during the 2021-2022 wrestling season. The subject's average weight at the completion of the 2021-2022 wrestling season was 164.96 ± 26.71 lb. (74.82 ± 12.12 kg).

3.3.2.1 Number of Weight Cuts

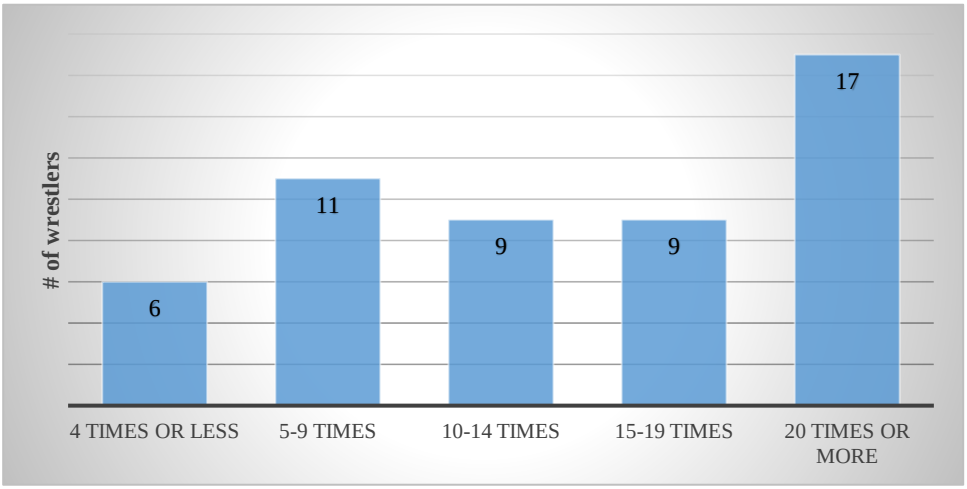

Figure 7 Number of Times Subjects Participated in Weight Cutting Behaviors for 2021-2022 Wrestling Season (n = 52)

Figure 7 represents the number of times participants engaged in weight cutting behaviors for the 2021-2022 wrestling season. Half of the subjects (50%, n = 26) utilized in weight loss mechanisms 15 times or more throughout the 2021-2022 wrestling season.

3.3.2.2 Duration of Weight Cuts

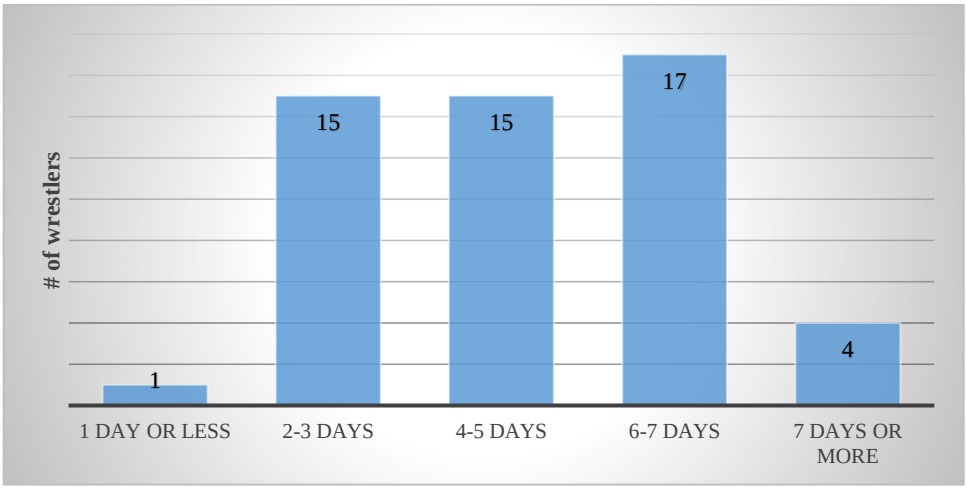

Figure 8 Number of Days Subjects Participated in Weight Cutting Behaviors Before Official Weigh-In for 2021-2022 Wrestling Season (n = 52)

Figure 8 represents the number of days participants engaged in weight cutting behaviors before the official weigh in for the 2021-2022 wrestling season. Most subjects (90.4%, n = 47) participated in weight cutting behaviors between two to seven days before the official weigh-in of competition.

3.3.2.3 Average Weight Lost During Weight Cuts

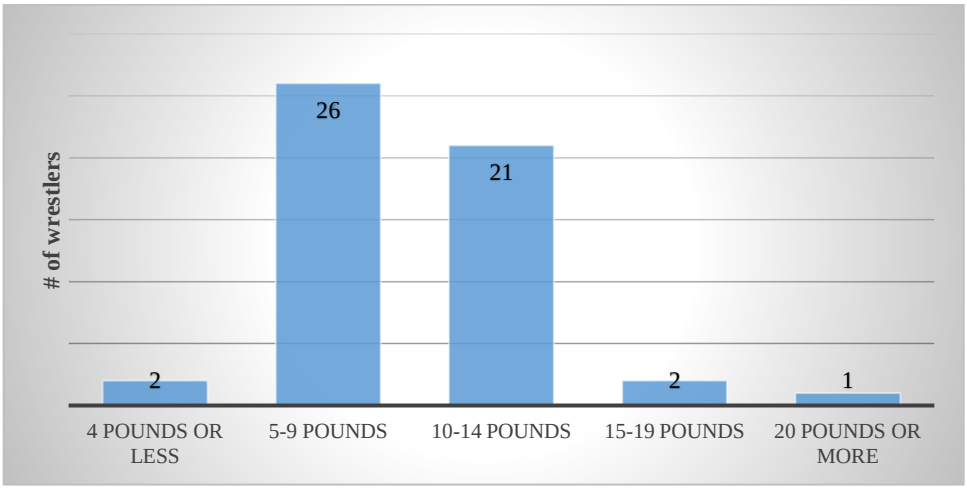

Figure 9 Average Weight (in pounds) Subjects Lost for Each Competition for 2021-2022 Wrestling Season (n = 52)

Figure 9 represents the average weight participants lost for each competition during the 2021-2022 wrestling season. Almost all the subjects (90.4%, n = 47) reduced an average weight between five and 14 pounds for competition.

3.4 Weight Loss Methods and Influences

In the last section of the survey, subjects were given a question regarding the specific types of weight loss mechanisms they used throughout the 2021-2022 wrestling season. Table 2 shows the frequencies at which the wrestlers used each method. The most used method for weight loss was increased exercise, with 96.2% (n = 50) exercising on top of their required practices at least once a week. Restricting food and fluid intake was implemented by 82.7% (n = 43) and 75% (n = 39) of subjects at least once a week, respectively. Many subjects that restricted food intake (38.5%, n = 20), fluid intake (51.9%, n = 27), and fasted (38.5%, n = 20) only participated in these methods one to two times per week. Further, heated wrestling rooms were utilized by 80.8% (n = 42) of subjects at one point during the 2021-2022 season. Close to half of the subjects (42.3%, n = 22) reported they never employed water loading and almost a quarter (n = 10, 19.2%) stated they do not use spitting anymore to lose weight for competition. Forced vomiting, enemas, laxatives, diuretics, and diet pills were reported to be never used by 90.4% (n = 47), 92.3% (n = 48), 86.5% (n = 45), 96.2% (n = 50), and 96.2% (n = 50) of subjects, respectively.

Table 2 Subjects' Weight Loss Methods for the 2021-2022 Wrestling Season and their Frequency of Use

Frequency of Use	Never used	Once-Twice a month OR LESS	1-2 times per week	3-5 times per week	6-7 times per week	I don't use anymore	Not Specified	Total
Gradual Dieting	2 (3.8%)	6 (11.5%)	7 (13.5%)	17 (32.7%)	20 (38.5%)	0	1 (1.9%)	52 (101.9%*)
Restricting Food Intake	3 (5.8%)	4 (7.7%)	20 (38.5%)	19 (36.5%)	4 (7.7%)	1 (1.9%)	1 (1.9%)	52 (100%)
Fasting	12 (23.1%)	14 (26.9%)	20 (38.5%)	3 (5.8%)	1 (1.9%)	2 (3.8%)	1 (1.9%)	52 (101.9%*)
Restricting Fluid Intake	2 (3.8%)	9 (17.3%)	27 (51.9%)	12 (23.1%)	0	2 (3.8%)	1 (1.9%)	52 (101.9%*)
Water Loading	22 (42.3%)	9 (17.3%)	8 (15.4%)	7 (13.5%)	5 (9.6%)	0	1 (1.9%)	52 (100%)
Increased Exercise	0	0	20 (38.5%)	18 (34.6%)	13 (25%)	1 (1.9%)	1 (1.9%)	52 (101.9%*)
Heated Wrestling Room	5 (9.6%)	6 (11.5%)	8 (15.4%)	15 (28.8%)	13 (25%)	4 (7.7%)	1 (1.9%)	52 (100%)
Spitting	35 (67.3%)	3 (5.8%)	0	2 (3.9%)	1 (1.9%)	10 (19.2%)	1 (1.9%)	52 (100%)
Forced Vomiting	47 (90.4%)	1 (1.9%)	0	0	0	3 (5.8%)	1 (1.9%)	52 (100%)
Enemas	48 (92.3%)	0	0	0	0	3 (5.8%)	1 (1.9%)	52 (100%)
Laxatives	45 (86.5%)	4 (7.7%)	0	0	0	2 (3.8%)	1 (1.9%)	52 (100 %)
Diuretics	50 (96.2%)	1 (1.9%)	0	0	0	0	1 (1.9%)	52 (100%)
Diet Pills	50 (96.2%)	0	1 (1.9%)	0	0	0	1 (1.9%)	52 (100%)

*Percentages over 100% because some individuals recorded 2 answers accounting for 53 total responses

The final question of the survey asked the subjects to answer who influenced their weight loss methods for the 2021-2022 wrestling season. Table 3 shows the level of influence each different individual(s) had on their weight loss methods from 2021-2022. Almost half of the subjects (40.4%, n = 21), answered their current coach had some or most influence on their weight loss methods. Roughly a third of subjects (32.7%, n = 17) answered an old coach had some or most influence on their methods. Fellow wrestlers on their team also had some influence on roughly a

third of subjects (32.7%, n = 17). Medical professionals educated on safe weight management including athletic trainers, physicians/doctors and nutritionists/dieticians had little to no influence in 73.1% (n = 38), 78.9% (n = 41), and 63.4% (n = 33) of subjects, respectively. Although, nutritionists/dieticians had some or most influence in 21.2% (n = 11) of wrestlers.

Table 3 Level of Influence on Subjects' Weight Loss Methods for the 2021-2022 Wrestling Season

Level of Influence	1 - no influence	2 - little influence	3 - unsure	4- some influence	5 - most influence	Not Specified	**Total**
Fellow Wrestlers on Team	14 (26.9%)	9 (17.3%)	9 (17.3%)	17 (32.7%)	0	3 (5.8%)	**52 (100%)**
Training Partners Outside Team	30 (57.7%)	4 (7.7%)	10 (19.2%)	5 (9.6%)	0	3 (5.8%)	**52 (100%)**
Current Coach	11 (21.2%)	11 (21.2%)	5 (9.6%)	13 (25%)	8 (15.4%)	4 (7.7%)	**52 (100%)**
Old Coach	15 (28.8%)	13 (25%)	4 (7.7%)	12 (23.1%)	5 (9.6%)	3 (5.8%)	**52 (100%)**
Parents/ Family	19 (36.5%)	8 (15.4%)	9 (17.3%)	11 (21.2%)	3 (5.8%)	2 (3.8%)	**52 (100%)**
Athletic Trainer	30 (57.7%)	8 (15.4%)	6 (11.5%)	3 (5.8%)	2 (3.8%)	3 (5.8%)	**52 (100%)**
Physician/ Doctor	34 (65.4%)	7 (13.5%)	5 (9.6%)	4 (7.7%)	0	2 (3.8%)	**52 (100%)**
Nutritionist/ Dietician	28 (53.8%)	5 (9.6%)	5 (9.6%)	9 (17.3%)	2 (3.8%)	3 (5.8%)	**52 (100%)**

3.5 Relationship between Wrestling History and Weight Loss

The following tables show the relationships between competitive wrestling history and prevalence of weight loss. Due to the smaller sample size, the answers for the questions regarding wrestling status and accomplishments were recoded into groups for analyzing the relationships between wrestling history and weight loss. Subjects who stated they participated in NCAA were identified as group 2 and the remaining subjects (high school, redshirt and other) were placed in group 1. Subjects with any wrestling accomplishment (NCAA All-American, qualified for NCAA

tournament, high school state winner or placer) were placed into the “yes” group and those that did not were placed in the “no” group. Tables 4-7 are crosstabulations of wrestling status from the 2021-2022 season with variables of weight loss prevalence and magnitude, including the average weight loss and the number and duration of weight cuts. Tables 8-11 are crosstabulations of wrestling accomplishments from the 2021-2022 season with the same prevalence and magnitude variables. Fisher’s exact test was used to determine association however, none of the crosstabulations were statistically significant. Table 4 and 8 display that subjects have similar prevalence rates for weight loss regardless of wrestling status and accomplishments. Furthermore, despite the lack of statistical significance, the “yes” accomplishment group tended engage in a higher number of weight cuts in the season than the “no” group as seen in table 9.

Table 4 Relationship of Weight Loss Prevalence and Wrestling Status from 2021-2022 Season

	Weight Cutter		**Total**
	No	Yes	
Group 1	6 (21.4%)	22 (78.6%)	28
Group 2	5 (14.3%)	30 (85.7%)	35
Total	11	52	63

Table 4 shows the relationship between the use of weight loss methods and wrestling status from the 2021-2022 wrestling season. For both groups, roughly ~80% of subjects engaged in weight loss methods. ($p = .517$)

Table 5 Relationship of Weight Cutting Frequency and Wrestling Status from 2021-2022 Season

	Number of Weight Cuts					Total
	4 times or less	5-9 times	10-14 times	15-19 times	20 times or more	
Group 1	4 (18.2%)	4 (18.2%)	4 (18.2%)	6 (27.3%)	4 (18.2%)	22
Group 2	2 (6.7%)	7 (23.3%)	5 (16.7%)	3 (10%)	13 (43.3%)	30
Total	6	11	9	9	17	52

Table 5 shows the relationship between the number of times the subject engaged in weight loss mechanisms and wrestling status from the 2021-2022 wrestling season. There were over twice the percentage of subjects in group two (n = 13, 43.3%) that cut weight 20 times or more compared to group one (n = 4, 18.2%). (p = .179)

Table 6 Relationship of Duration of Weight Cut and Wrestling Status from 2021-2022 Season

	Duration of Weight Cuts					Total
	1 day or less	2-3 days	4-5 days	6-7 days	7 days or more	
Group 1	1 (4.5%)	7 (31.8%)	5 (22.7%)	8 (36.4%)	1 (4.5%)	22
Group 2	0	8 (26.7%)	10 (33.3%)	9 (30%)	3 (10%)	30
Total	1	15	15	17	4	52

Table 6 shows the relationship between the number of days subjects used weight loss methods before competition and wrestling status from the 2021-2022 wrestling season. (p = .695)

Table 7 Relationship of Average Weight Lost and Wrestling Status from 2021-2022 Season

	Average Weight Cut					Total
	4 pounds or less	5-9 pounds	10-14 pounds	15-19 pounds	20 pounds or more	
Group 1	1 (4.5%)	11 (50%)	8 (36.4%)	1 (4.5%)	1 (4.5%)	22
Group 2	1 (3.3%)	15 (50%)	13 (43.3%)	1 (3.3%)	0	30
Total	2	26	21	2	1	52

Table 7 shows the relationship between the average amount of weight lost in pounds and wrestling status from the 2021-2022 wrestling season. (p = .910)

Table 8 Relationship of Weight Loss Prevalence and Wrestling Accomplishments from 2021-2022 Season

	Weight Cutter		Total
Accomplishments	No	Yes	
No	6 (16.7%)	30 (83.3%)	36
Yes	5 (18.5%)	22 (81.5%)	27
Total	11	52	63

Table 8 shows the relationship between the use of weight loss mechanisms and wrestling accomplishments from the 2021-2022 wrestling season. Regardless of having an accomplishment or not, more than 80% of the subjects engaged in weight reduction tactics. (p = 1.00)

Table 9 Relationship of Weight Cutting Frequency and Wrestling Accomplishments from 2021-2022 Season

	Number of Weight Cuts					Total
Accomplishments	4 times or less	5-9 times	10-14 times	15-19 times	20 times or more	
No	6 (20%)	8 (26.7%)	4 (13.3%)	3 (10%)	9 (30%)	30
Yes	0	3 (13.6%)	5 (22.7%)	6 (27.3%)	8 (36.4%)	22
Total	6	11	9	9	17	52

Table 9 shows the relationship between the number of times the subject engaged in weight loss mechanisms and wrestling accomplishments from the 2021-2022 wrestling season. The accomplishment group had higher percentages of subjects within the 10-14 times, 15-19 times, and 20 or more times, while the non-accomplishment group had higher percentages in the 5-9 times and 4 or less times. (p = .073)

Table 10 Relationship of Duration of Weight Cut and Wrestling Accomplishments from 2021-2022 Season

	Duration of Weight Cuts					Total
Accomplishments	1 day or less	2-3 days	4-5 days	6-7 days	7 days or more	
No	1 (3.3%)	9 (30%)	10 (33.3%)	8 (26.7%)	2 (6.7%)	30
Yes	0	6 (27.3%)	5 (22.7%)	9 (40.9%)	2 (9.1%)	22
Total	1	15	15	17	4	52

Table 10 shows the relationship between the number of days subjects used weight loss methods before competition and wrestling accomplishments from the 2021-2022 wrestling season. ($p = .757$)

Table 11 Relationship of Average Weight Lost and Wrestling Accomplishments from 2021-2022 Season

	Average Weight Cut					Total
Accomplishments	4 pounds or less	5-9 pounds	10-14 pounds	15-19 pounds	20 pounds or more	
No	2 (6.7%)	13 (43.3%)	13 (43.3%)	2 (6.7%)	0	30
Yes	0	13 (59.1%)	8 (36.4%)	0	1 (4.5%)	22
Total	2	26	21	2	1	52

Table 11 shows the relationship between the average amount of weight lost in pounds and wrestling accomplishments from the 2021-2022 wrestling season. ($p = .331$)

4.0 Discussion

There have been several studies investigating the weight loss methods of collegiate and high school wrestlers,[12, 26-28] however, they all contain data from the 1990's. The few studies conducted within recent years been master theses[109-111] or studies with athletes outside of the United States,[7-11, 13,14] with just one involving American wrestlers and other athletes.[8] It can be assumed that the NCAA as well as other sport governing bodies such as WADA know their competitors may engage in dangerous methods since several methods are banned.[18, 19, 30] Despite this, due to the lack of research, there is no current understanding of weight loss practices in NCAA collegiate wrestlers. Thus, the purpose of this study was to investigate the prevalence and magnitude of weight loss techniques among NCAA collegiate wrestlers. Furthermore, this study aimed to understand the influences of weight loss strategies and describe any correlations between competitive wrestling history and weight loss. Qualtrics based surveys were distributed to four NCAA institutions in western Pennsylvania and the surrounding areas to determine the weight loss prevalence and magnitude statistics. The results of this study show that rapid weight loss methods, such as increased exercise and fluid or food restriction, remain prevalent with potentially increasing magnitudes in male collegiate wrestlers.

4.1 Prevalence of Weight Loss and Specific Methods

The first aim of this study was to determine the prevalence of rapid weight loss methods within NCAA collegiate wrestlers. The 82.5% prevalence rate calculated from this study is

consistent with previous investigations that discovered ~65-90% of collegiate and high school wrestlers within the United States that utilized rapid weight loss practices.[12, 26, 27] One investigation included wrestlers from the United States with a rate of 97%, but it is not known what level of competition the athletes compete in due to the recruitment methods of the study.[8]

The individuals that answered 'yes' to implementing rapid weight loss methods from the 2021-2022 season, answered a series of questions related to the specific methods and magnitude of those techniques during that period. The results of those questions determined the frequency of use for specific types of weight loss methods by the NCAA wrestlers. As previously mentioned, there are varying methods of weight loss utilized by wrestlers and combat athletes to reduce their body mass that can be grouped into three categories: body water, glycogen storage and GI tract adjustment. The body is largely comprised of water which allows athletes to manipulate their water content and subsequently alters their body mass. Although these are transient changes and their body mass will increase once the athlete consumes fluids or food, these methods allow the athlete the ability to complete the official weigh-in prior to replenish their lost water and energy stores.

The findings of this study show the most used weight loss methods are those altering one's body water. Of the 52 wrestlers, the weight loss method with the highest reported frequency was increased exercise with approximately 90% (n = 50) of individuals engaging in this technique at least once a week. Increased exercise is the most common form of active sweating to manipulate body water with rates throughout all combat sports between ~70-95%. Of highest concern was that over 80% (n = 42) stated they trained in heated wrestling rooms at one point during the season to elevate their weight loss, despite the NCAA prohibiting the practice of heated wrestling rooms, saunas, and/or steam-rooms.[18] In addition, 75% (n = 39) of subjects restricted their fluid intake at least once a week but, many of those individuals (51.9%, n = 27) restricted their intake only one

to two times per week, which were likely on the days of competition to maintain their body mass before the official weigh-in. Practicing or competing in a dehydrated and/or reduced energy state may induce physiological effects such as damaged cardiovascular and thermoregulatory functions and can be detrimental to physical performance.

Some forms of body water adjustment were not as commonly used such as water-loading, diuretics, and spitting. Water loading was utilized by 55.7% (n = 29) of wrestlers at least once throughout the season and seems to have increasing rates than previously observed.[8] Although this method is relatively prevalent in other combat sports including MMA, boxing, MT/K, BJJ and taekwondo, due to process of planning and timing of water intake it may be difficult for collegiate wrestlers that compete on a weekly basis. It is important to note that there is little information regarding the potential dangers that may be associated with this method. Diuretics, another method banned by the NCAA and the World Anti-Doping Agency (WADA), were taken once to twice a month or less by only one subject (1.9%) which is less than the previous usage rates in combat sport athletes reported to be between 5-15%.[7-14, 26, 28] Spitting is a direct method of reducing body water and was reported to be used previously but not anymore by roughly a quarter of subjects (19.2%, n = 11). Spitting was not previously mentioned; however, research has shown roughly ~20-45% of combat athletes engage in this method.[7, 8, 12-14, 27]

Glycogen storage adjustment practices suggest they are regularly used by collegiate wrestlers, but not with the same consistency as the body water methods. Only 46.5% (n = 24) wrestlers fasted, however, 82.7% (n = 43) of subjects restricted their food intake once a week at minimum. Many of the individuals (38.5%, n = 20) that restricted their food intake only utilized this method one to two times per week, which like fluid restriction, can be assumed that it is done on the day(s) of competition. Increased exercise can be categorized as both body water and

glycogen storage adjustment; however, since these methods are implemented within days of competition, the majority of changes the athletes are experiencing in their body mass are due to their fluctuating body water. A theory as to why these methods are not as prevalent as the others may be due to the short time between competition and the lack of ability to successfully manipulate their body's glycogen and fat stores compared to water. Despite the alteration of glycogen storage being not as prevalent as body water methods, there are many concerns directly aligned with these methods such as disordered eating habits, RED-S, and mood/cognitive impairments.

Unconventional means of altering the gastrointestinal tract were all seen within extremely low prevalence rates. Subjects employed laxatives (7.7%, n = 4) and forced vomiting (1.9%, n =1) only one to two times a month or less, while no one utilized enemas. Although these methods are seen with extremely low usage rates, it is concerning that researchers have been including these methods within survey-based studies since at least the early 1990's, but there is little to no research on the consequences of most GI tract methods, including the ones listed above as well as other irregular means such as rubber suits, diuretics, and diet pills.[26] Of the three groups of forms of rapid weight loss, body water adjustment continues to be the most established form of weight loss followed by glycogen storage regulation, and lastly, GI tract manipulation.

4.2 Magnitude of Weight Loss

To assess the magnitude of weight loss within NCAA collegiate wrestlers, the study focused on three factors: the average weight lost and the frequency and duration of weight reduction mechanisms. Over two-thirds of subjects (67.3%, n = 35) utilized weight loss techniques for competition at least ten times during the 2021-2022 season. In addition, close to one third

(32.7%, n = 17) reduced their weight 20 times or more, an increase to the ranges from previous studies of collegiate/high school wrestlers that were between 8 and 15.[12, 26] Almost every individual (90.4%, n = 47) lost weight between 5-14 pounds for competition, although 40.4% (n = 21) reduced 10-14 pounds on average, which was also an increase of the average weight reductions seen in the past of ~6 pounds.[12, 26, 27] Lastly, 90.4% (n = 47) of the subjects' weight loss process duration was between two to seven days before the day of competition, which is very similar to the previous literature with wrestlers losing body mass in roughly three to five days.[26, 27] The magnitude of rapid weight loss within collegiate wrestlers is has similarities in the frequency and duration of the weight loss process; however, average weight lost is slightly elevated within this study than in previous research.[12, 26, 27]

4.3 Weight Loss Influences

The last question of the questionnaire identified the level of influence different individuals may have on each subject's weight loss processes. Of the subjects that reported use of weight loss methods, 40.4% (n = 21), 32.7% (n = 17), and 26.9% (n = 14), stated their current coach, old coach and parents/family had some or most influence on their weight loss habits, respectively. Individuals with the most knowledge of managing weight loss such as nutritionists/dieticians, athletic trainers and physicians/doctors did not have as much influence. Although 21.2% (n = 11) stated that a nutritionist/dietician had some or most influence, only 9.6% (n = 5) and 7.7% (n = 4) identified athletic trainers and physicians/doctors having some or most influence. Further, almost a third of subjects (32.7%, n = 17) answered that fellow wrestlers on team had some influence on their weight loss methods. Compared to former studies, coaches, fellow wrestlers, and

family/parents were also found to be the most influential on a wrestler's weight loss, while health professionals had little to no impact.[7-14] One of the previous studies observed 40.2% of wrestlers changing their weight loss behaviors due to a newly implemented NCAA weight management rule.[12] It is unknown if the wrestlers in this study are receiving any information regarding weight management and adequate nutrition intake from their team's athletic trainer and/or nutritionist/dietician. Further, the lack of influence between all the listed individuals infers that these athletes are receiving information from outside sources such as social media, internet, etc. The athletes may also have developed habits over the course of their wrestling career, that does not warrant seeking help from others. The coaches who have historically had the most influence on the athletes may need to assist in educating the correct techniques or initiate the relationships between the sports medicine professionals to help guide their wrestlers weight management.

4.4 Relationship between Wrestling History and Weight Loss

There was no relationship between the subjects' competitive wrestling history with the prevalence and magnitude of weight loss methods. Wrestlers were divided into a group based upon their answers to two questions. It was believed that there would be a difference in the prevalence and magnitude of weight loss within wrestlers with different competitive wrestling histories. This was assumed because previous research has observed differences within wrestlers depending on their competitive level (high school vs. collegiate [26], cadet vs. junior [28]), age they began wrestling[27], wrestling accomplishments[28], academic year[12], NCAA Division, and weight class[12, 28].

Prior research found placers at the Cadet and Junior National Freestyle/Greco-Roman Wrestling Championship gained significantly more weight than non-placers after the official

weigh in. Weight gained after the weigh in was used because it is considered a result of the weight loss before the official weigh in and is replenished when the athlete intakes food and fluid between the weigh in and their match.

The present study only investigated discrepancies within competitive level and wrestling achievements. Athletes that had an accolade from the 2021-2022 wrestling season were placed into one group while those that did not have any were placed into another. It could be argued that wrestlers with an accomplishment would have more intense weight loss practices because they are willing to push their body to those limits. However, the reverse could be presented under the assumption the athlete has a better understanding of weight management because of past success at advanced levels. Despite the lack of statistical significance, it was observed that subjects within the accomplishment group tended to have a higher number of weight cuts completed for the season, as 63.7% had 15 or more weight cuts in a season compared to only 40% in the non-achievement group. This may be due to the increased number of matches those subjects have because of their extended season during post-season tournaments. The overall lack of correlation found between weight loss and wrestling status, or accomplishments is peculiar as is that there are no changes seen between wrestlers of skill and/or competition level.

4.5 Limitations

The first limitation of this study was the survey instrument used to capture data. Specifically, two of the questions (#4 & #5) from the survey did not yield a response from any of the 63 individuals included within the data analysis. The investigators could not figure out a cause for this, and the questions were not included in the results section. In addition, question (#16) had

to be eliminated because of a grammar mistake in the question which did not allow for the best understanding of the targeted magnitude of weight loss within the wrestlers. Furthermore, the formatting of two questions (#18 & #19) caused for some subjects to respond with more than one answer. Another limitation of the survey was that subjects who reported they did not use weight loss methods were able to answer the question regarding the frequency of specific methods. This led to an interesting discovery since many of the wrestlers that answered "no" to using weight loss methods indicated a frequency of usage for some of the specific practices. To add, specific weight loss techniques including saunas and rubber/plastics suits were not listed within that question. Although these methods are not as common, they were important to include because saunas and rubber suits are banned approaches by the NCAA.

The study was also limited by the recruitment methods. For optimal data collection, the primary investigator along with their committee, thought it would be best to have in-person, face-to-face data collection rather than sending the survey electronically to the athletes. Although this method was deemed to be extremely useful, it did have some drawbacks. There was no way of correlating the number of wrestlers who were met in-person versus those that filled out the survey. In addition, the team's athletic trainer was instructed to inform the wrestlers to bring their phones to the meeting. Despite this, there was miscommunication for the first meeting and few to none had their mobile devices on hand to complete the survey. Moreover, this method of data collection was limited by the PI's traveling ability to each institution and restricted the number of individuals that could be recruited.

4.6 Future Research

Future studies should focus on the understanding the prevalence and magnitude of rapid weight loss within a larger population of NCAA wrestlers. Additionally, researchers could investigate how the wrestlers feel about their need to maintain their weight and specifically if they experience more success or health complications from weight loss with self-reported measures and/or injury occurrence. Also, it would be beneficial to understand if the athletes are being educated on proper weight management as well as examining the content of any ongoing education practices by healthcare professionals. Many of the subjects in the current study attended a Division 1 institution with adequate resources; however, it would also be useful to identify if there is a difference in educational practices within and among NCAA divisions. Moreover, with the emergence of social media and easily accessible information via phones, computers etc., it should be considered that some athletes personally research information on weight management or emulate ideologies discovered through YouTube, Instagram, Twitter, and other social media platforms.

The emergence of female wrestling throughout all levels of competition, Olympic, collegiate, high-school and youth warrant the need for research specifically on the weight loss practices within female wrestlers. There has been previous research on weight reduction methods in other combat sport athletes, however, no study to date has examined the weight cutting mechanisms within collegiate female wrestlers.

4.7 Conclusion

From the current study we can conclude that NCAA wrestlers continue to utilize rapid weight loss methods with high prevalence rates. Further, the magnitude of weight reductions, specifically the frequency, amount of body mass, and duration, have seen little changes since the implementation of the Wrestling Weight Certification Program (WWCP). In addition, it appears that these athletes have developed cultural habits and mechanisms to maintain their weight for competition that are likely learned from the coaches and fellow wrestlers around them. Unfortunately, many of the preferred methods by the wrestlers will typically induce dehydration, and/or low energy availability such as increased exercise, restricting food/fluids, as well as some banned methods such as training in a heated wrestling room. Lastly, it cannot be determined that there is any relationship between competitive wrestling history and the prevalence or magnitude of rapid weight loss within collegiate wrestlers; however, this may have been inconclusive due to the smaller sample size. In conclusion, this study identified that rapid weight loss is extremely common among NCAA wrestlers and warrants potential rule modifications such as a monitoring the methods of weight loss with random check ins by NCAA officials or increased ramifications for rules violations, in addition to cultural changes within the sport by improving education for better weight management skills in collegiate wrestlers to keep them safe and healthy for optimal performance.

Appendix A Qualtrics Survey Questions

Consent: If you are receiving this survey, it is because you are a wrestling student athlete at a NCAA institution. This research is being conducted within the Sports Medicine and Nutrition Department at the University of Pittsburgh (Pittsburgh, PA). The purpose of this study is to determine the current prevalence and magnitude of rapid weight loss strategies among NCAA wrestlers. The survey will take approximately 5-10 minutes to complete. By completing the survey, you are giving consent to participate in the study. Participation is completely voluntary. The risks of the study are minimal. All survey responses will be collected anonymously and any information that may include the student athlete's identity will be omitted. Only members of the research committee will have access to the survey results. Results from this study will give a current understanding of the rapid weight loss methods used in collegiate wrestlers. This study will advance the literature regarding rapid weight loss in wrestlers and other combat sport athletes to help minimize the negative effects these methods may have on individuals and inform athletes of safer weight management.

Consent: Do you consent to these terms?

- ○ No
- ○ Yes

Introduction: You are now entering the Rapid Weight Loss survey. The survey will consist of 4 sections.

Section 1: Section 1 will gather subject demographic information.

Q1 Select the NCAA division you participate in.

- Division I
- Division II
- Division III

Q2 Select your current year in school.

- Freshman
- Sophomore
- Junior
- Senior
- 5th year
- Graduate

Q3 What is your age (in years)?

- 17
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25
- 26
- 27
- 28

Q4 At what age (in years) did you begin wrestling competitively?

Q5 At what age (in years) did you begin cutting weight? If never cut weight before, put "never."

Q6 What is your height?

Q7 What is your current weight (in pounds)?

Q8 What is your estimated weight class (in pounds) for the 2022-2023 (CURRENT) wrestling season?

- ○ 125
- ○ 133
- ○ 141
- ○ 149
- ○ 157
- ○ 165
- ○ 174
- ○ 184
- ○ 197
- ○ 285

Section 2: Section 2 will gather information of your competitive wrestling history and have specific questions regarding the 2021-2022 (LAST) wrestling season.

Q9 What best describes your wrestling status for the 2021-2022 (LAST) wrestling season?

- ○ NCAA
- ○ High School
- ○ Redshirt
- ○ Did not compete
- ○ Other (explain)

Q10 What best describes your accomplishments during the 2021-2022 (LAST) wrestling season?

- ◯ Qualified for NCAA tournament
- ◯ NCAA All-American (top 8)
- ◯ High School State Placer
- ◯ High School State Winner
- ◯ None of the above

Section 3: Section 3 will gather information about your weight loss history and have specific questions regarding the 2021-2022 (LAST) wrestling season.

Q11 What best describes your weight class (in pounds) for the 2021-2022 (LAST) wrestling season?

- ◯ 125
- ◯ 133
- ◯ 141
- ◯ 149
- ◯ 157
- ◯ 165
- ◯ 174
- ◯ 184
- ◯ 197
- ◯ 285

Q12 Did you cut weight for competition for the 2021-2022 (LAST) wrestling season?

- ◯ No
- ◯ Yes

Q13 How many times did you engage in weight cutting behaviors for the 2021-2022 (LAST) wrestling season?

- 4 times or less
- 5-9 times
- 10-14 times
- 15-19 times
- 20 times or more

Q14 How many days did the weight cutting behaviors take place before the official weigh for the 2021-2022 (LAST) wrestling season?

- 1 day or less
- 2-3 days
- 4-5 days
- 6-7 days
- 7 days or more

Q15 How much weight on AVERAGE did you lose for each competition for the 2021-2022 (LAST) wrestling season?

- 4 pounds or less
- 5-9 pounds
- 10-14 pounds
- 15-19 pounds
- 20 pounds or more

Q16 How much weight is the most you lost for one single competition for the 2021-2022 (LAST) wrestling season?

- 4 pounds or more
- 5-9 pounds
- 10-14 pounds
- 15-19 pounds
- 20 pounds or more

Q17 What was your weight (in pounds) at the completion of the 2021-2022 (LAST) wrestling season?

Section 4: Section 4 will gather information on the weight loss methods you have used, and the influences of the methods used.

Q18 Below listed are various forms of weight cutting methods. Please list the frequency of use for each method for the 2021-2022 (LAST) wrestling season.

	6-7 times per week	3-5 times per week	1-2 times per week	Once-Twice a month OR LESS	Never used	I don't use anymore
Gradual Dieting	☐	☐	☐	☐	☐	☐
Restricting Food Intake (skipping 1-2 meals a day)	☐	☐	☐	☐	☐	☐
Fasting (not eating all day)	☐	☐	☐	☐	☐	☐
Restricting Fluid Intake	☐	☐	☐	☐	☐	☐
Water Loading (high water intake days before weigh-in followed by complete cessation one day before weigh-ins)	☐	☐	☐	☐	☐	☐
Increased Exercise (outside of mandatory practices)	☐	☐	☐	☐	☐	☐
Training in Heated Wrestling Room	☐	☐	☐	☐	☐	☐

Spitting	☐	☐	☐	☐	☐	☐
Forced Vomiting	☐	☐	☐	☐	☐	☐
Enema	☐	☐	☐	☐	☐	☐
Laxatives (increases bowel movements - e.g., Dulcolax, Senokot, etc.)	☐	☐	☐	☐	☐	☐
Diuretics (increases urine production - e.g., water pils, Diurex, etc.)	☐	☐	☐	☐	☐	☐
Diet Pills (e.g., Garcinia Cambogia, Hydroxycut, Alli, etc.)	☐	☐	☐	☐	☐	☐

Q19 Identify the amount of influence each of the following has on your weight loss methods used for the 2021-2022 (LAST) wrestling season.

	1 - no influence	2 - little influence	3 - unsure	4 - some influence	5 - most influence
Fellow Wrestlers on Team	☐	☐	☐	☐	☐
Other Training Partners (not on same team)	☐	☐	☐	☐	☐
Coach (current)	☐	☐	☐	☐	☐
Coach (old)	☐	☐	☐	☐	☐
Parents/Family Members	☐	☐	☐	☐	☐
Team Athletic Trainer	☐	☐	☐	☐	☐
Physician/Doctor	☐	☐	☐	☐	☐
Dietician/Nutritionist	☐	☐	☐	☐	☐

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