WEIGHT CUTTING AND CONSIDERATIONS FOR NUTRITION SUPPORT IN COMBAT SPORTS

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INTRODUCTION

Fighters aim to possess high degrees of power to weight to maximise their athletic attributes at a given weight. In most combat sports, competitors are separated into weight divisions or categories. Prior to competition, athletes have their body mass (BM) verified at an official "weigh-in" to ensure they have "made weight". The period of time between weigh-in and competition can vary between 3 to 30 hours across Olympic and professional combat sports (Table 1). Recovery times of as little as 15 minutes are also seen.

The process of manipulating body weight around weigh-in times for a competitive advantage is a practice adopted since weight divisions were conceived. Nutrition and training strategies that reduce body fat and maximise lean mass are common. In addition to these chronic manipulations most fighters apply acute weight loss (AWL) strategies up to weigh-in. This process is often referred to as cutting weight. This temporarily lowers body mass (BM) to make weight at a lower division than a day-to-day weight (and thus compete against smaller opponents). Athletes then attempt to reverse the negative performance effects of AWL during the recovery period[1].

Fighters cite performance as well as psychological benefits as reasons for engaging in these practices. Evidence supports that AWL can increase success in some combat sports[1,2,3]

This article examines various AWL strategies used by combat sport athletes, considers the possible physiological effects and burdens of these. Finally, subsequent nutritional strategies that practitioners working with combat athletes making weight could apply to optimise performance and athlete health prior to competition.

Cutting Weight: How much and which combat sports could benefit most?

Recovery time available post weigh-in will largely determine the magnitude of AWL realistically achievable. As a guide, with ≥ 12 h between weigh-in and competition, up to 10% BM AWL may be possible[2]. Whereas athletes competing in sports with limited recovery time (e.g. ≤ ~6 h) should aim for no more than ~5% BM acute losses[2]. If sensibly implemented cutting weight in scenarios with lengthy recovery times between weigh-in and competition, allowing for substantial BM manipulation may be a pragmatic way to optimize competitiveness. However, this might not be the case for all combat sport. For example, Grappling sports (where the goal is to manipulate an opponent's body and impose one's own body weight) appear to benefit from increased BM relative to an opponent, more so than striking sports (where success depends more on a strategic and tactical implementation of movement, footwork, speed, and successfully landing blows to an opponent's body).

Nutrition professionals and coaches should advise against excessively large magnitudes of acute weight loss and educate athletes to make use of safer, evidenced based methods of weight cutting. Under some conditions, negative mild impacts on health and performance may be possible where 5% and up to 10% acute BM losses are achieved[2,3]. However, utilizing

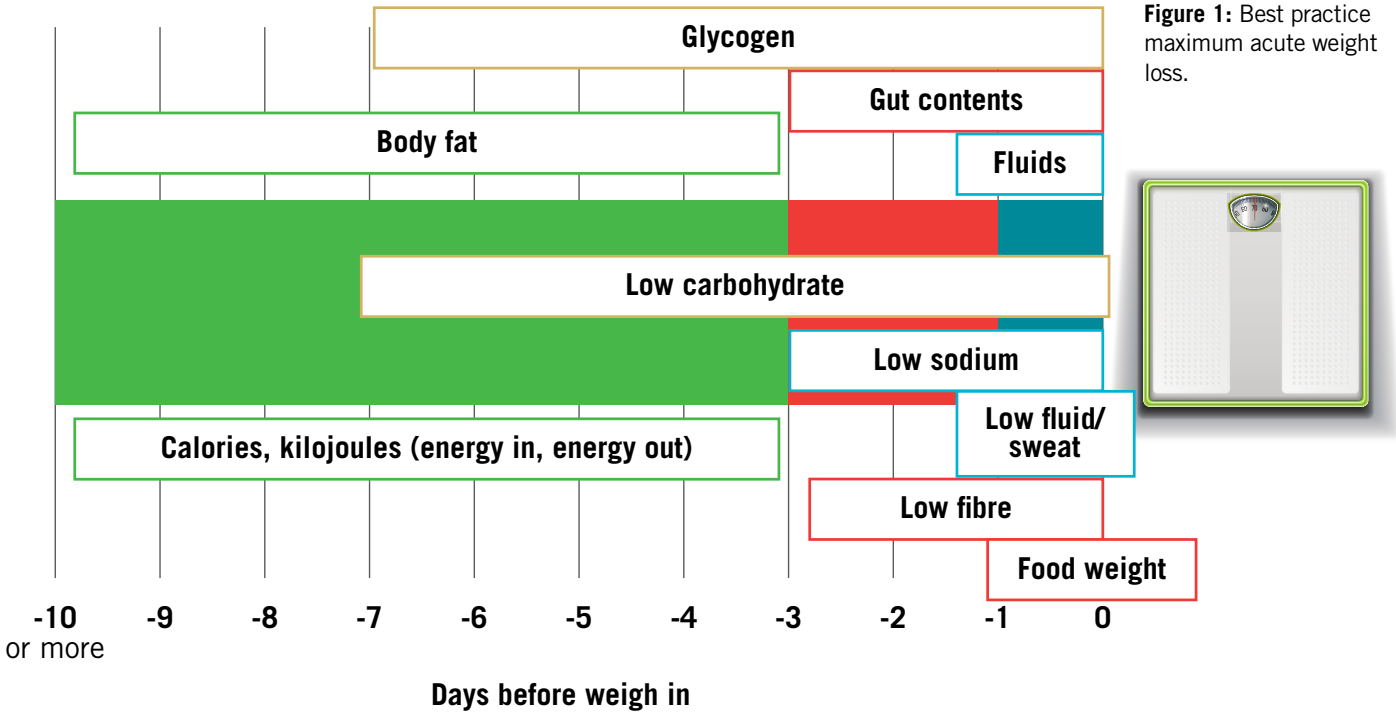

Figure 1: Best practice maximum acute weight loss.

Table 1

Sport	*Weigh in Procedures*
Judo	*Weigh-in conducted evening before competition, with random weight checks morning of competition – prohibiting weight gain of great than 5%*
Amateur boxing	*General weigh-in conducted on day 1 of competition for all athletes. Individuals then required to weigh-in each morning of their bouts*
Wrestling	*Weigh-in conducted morning of competition*
Taekwondo	*Weigh-in conducted evening before competition, with random weight checks morning of competition – prohibiting weight gain of great than 5%*
Karate	*Varies by organization. Olympic rules dictate weigh-in to occur at latest the day before competition. Other organizations may conduct morning of competition*
Brazilian Jiu Jitsu	*Weigh-in generally conducted day of competition. As close as 30 minutes prior to competition. Less frequently morning of competition and occasionally day before competition*
Professional boxing	*Weigh-in conducted day before competition, generally 20-30 h prior.*
Mixed martial arts	*Weigh-in generally conducted day before competition, generally 20-30 h prior. Infrequently, amateur competitions may conduct weigh-in morning of competition*

Table 1: Examples of Weigh-in regulations and competition details for different combat sports.

CHRONIC/ACUTE MANIPULATIONS OF BODY COMPOSITION VARIABLES

Chronic manipulations	*Acute manipulations*
• *Body fat* • *Protein component of muscle mass*	• *Body water* • *Glycogen content* • *Gut content*

solely dehydration to achieve these losses is unadvisable and dangerous to health. Instead, a calculated manipulation of gut content, carbohydrate stores and finally body water, implemented in a strategic fashion should be utilized (Figure 1, Table 1).

The starting point prior to AWL should represent a BM associated with a well-nourished, euhydrated state, allowing ample opportunity for sizeable manipulations of these compartments

Acute versus Chronic Weight Loss Strategies

Weight loss over a longer period and the discipline to minimise large body weight fluctuations is of fundamental importance for combat athletes. The lack of a structured long-term weight management plan is often responsible for an athlete undertaking excessive amount of acute weight loss. Therefore, long term weight management planning, and engaging athletes in good nutrition practices over the year with agreed BM target variations out of competition periods is vital.

However, chronic weight loss is not without its concerns. Prolonged energy deficits predispose athletes to a host of negative outcomes such as muscle loss, reduced metabolic rate, impaired immune status, low bone mineral density, alongside several psychological issues such as those relating to body image, disordered eating and eating disorders[1,2,3]. Of note is the increased likelihood of disordered eating both during ones career and even in later life. However, it could be argued that frequent reliance on AWL strategies is more likely to lead to disorder eating than more controlled and supervised chronic weight management programs.

This illustrates why professionals working in this discipline need to be well versed in both chronic and acute weight loss techniques and take a pragmatic approach to balancing competing interests and making trade-offs when it comes to short and long term goals, performance and athlete's physical and mental wellbeing.

Common Acute Weight Cutting Strategies and Physiological Implications

AWL strategies should be viewed as "sprinkles on the cake" and not the primary method of making weight. To make weight, athletes routinely increase exercise, implement both passive (e.g. saunas, hot baths) and active dehydration (e.g. training in sweat suits), practice various forms of fluid and dietary restriction (including avoiding specific foods or nutrients, limiting energy intake and complete fasting) and even go as far as to use laxatives, bowel preparation formulas and (often banned) pharmacological diuretics, in the hours and days prior to weigh-in.

2	High carbohydrate diet
Breakfast	Eggs and white bread 
Mid morning	Greek yoghurt 
Lunch	Chicken and white rice 
Afternoon	Protein shake on water 
Dinner	Steak and white potato 

Figure 2: Example low fibre, moderate carbohydrate diet, suitable for those wishing to reduce gut content but still maintain glycogen stores.

Combat sport athletes commonly lose 5-10% BM in the week prior to weigh-in[1], with some athletes undertaking AWL efforts far in excess of this. Consequently, significant anaerobic and (especially) aerobic performance decrements and severe health consequences (including death) may arise from extreme and excessive AWL. Therefore, experts working with these populations must balance athletes' desires to achieve (real or perceived) advantages with concerns for their physical, mental and emotional safety. It is generally recommended that youth athletes avoid engaging in acute weight loss strategies (especially of moderate to large magnitude), and instead adopt good nutrition practices and devote concentration and energy to training and preparing for competition physically and mentally.

The 3 main methods of AWL frequently used by professionals with combat athletes are now reviewed.

MANIPULATION OF GUT CONTENT

Many of the dietary restrictions athlete use result in reduced mass of intestinal contents and thus total BM[1]. Complete fasting for days and/or laxative use may be effective in cleansing the bowel, however will also impact on energy and macronutrient intake/absorption (alongside performance reductions[1]). Therefore, strategies which reduce total food volume without restricting energy and macronutrient intake are preferable. This is especially true for athletes who have limited time post weigh-in to effectively rehydrate and refuel prior to competition.

Certain types of dietary fiber can both slow gut transit times of foods as well as draw water into the intestinal space, "bulking" stools. Thus, if one reduces the consumption of "bulking" fiber-rich foods, a reduction of undigested plant matter within the gut and a reduction in water drawn into the intestinal space (and lower BM) follows. A linear relationship exists between fiber

3	Low carbohydrate diet	
Breakfast	Eggs and vegetable	
Mid morning	Greek yoghurt	
Lunch	Chicken and salad	
Afternoon	Protein shake on water	
Dinner	Meat and vegetable	

Figure 3: Example low carbohydrate day, high fibre diet, suitable for those wishing to deplete glycogen stores without reducing gut content.

4	Low fiber & low carbohydrate diet	
Breakfast	Eggs	
Mid morning	Greek yoghurt	
Lunch	Chicken with high fat avocado and cream sauce	
Afternoon	Protein balls made with peanut butter and protein powder	
Dinner	Meat with high fat peanut sauce	

Figure 4: Example low carbohydrate diet, low fibre diet, gut content concurrent to depleting glycogen stores.

intake and bowel content. The consumption of a low fiber diet for just two days begins cleansing the bowel, with seven days being as effective as a bowel preparation formula, while resulting in less physiological stress[4].

Limited research in this area exists, and whole gut transit times vary widely between individuals from 10 - 96 h[5], making precise prescription difficult. However, significant weight loss (~1.5% BM) is achieved following 48 h of fiber restriction (≤ 10 g/d), with no further significant losses in most individuals[6]. Thus, 48 h seems a sensible starting point to implement this approach, noting some individuals may benefit from a fibre restriction > 48 h[2] (Figure 2).

MANIPULATION OF GLYCOGEN CONTENT

Dietary carbohydrate is stored for later use in skeletal muscle and the liver as glycogen. Glycogen binds to water at a ratio of ~1:3, the manipulation of which offers another method AWL. Both the restriction of dietary carbohydrate coupled with regular training, or an increase in training alongside habitual carbohydrate intake, will decrease glycogen stores. Prior to weigh-in, athletes tend to taper, decreasing training, and therefore reducing carbohydrate intake without increasing training would be the logical strategy. A very low carbohydrate diet (< 50 g/d), combined with training and a minor energy deficit (< 10%) can achieve a ~2% BM reduction[7]. However, the exact magnitude BM loss possible, and the time frame and degree of carbohydrate restriction required, will vary between athletes and situations. A general recommendation of < 50 g/d for 3-7 d for athletes wanting to deplete glycogen prior to weigh-in has been suggested[2]. Athletes should consider the time available post weigh-in to refuel and the requirements of their sport (i.e., fuel demands, need for repeated weigh-ins, etc.) when deciding how to implement glycogen depletion to achieve AWL (Figures 3 and 4).

MANIPULATION OF BODY WATER

Water constitutes ~60% of the human body in the general population and more in athletes with lean physiques. Given the size of this compartment and the rapid nature in which fluctuations are possible, dehydration is the primary AWL strategy used by many athletes. Although mild dehydration (< 2% BM) is unlikely to affect relevant performance, larger magnitudes may, particularly when post weigh-in recovery

time is limited[2,3]. Two methods to decrease body water exist; consume less fluid and/or excrete more. A 24 h fluid restriction (< 300 ml (10 oz)) may result in 1.5 - 2% BM loss[8]; however, magnitudes greater than this following increased sweating via both active (exercise induced) and/or passive methods (i.e., saunas, heated environments, sweat suits etc.) are common[1]. Overnight "drifts" in weight are individual and dependant on individual sweat rate but can be an important part of a strategy.

It is important to note the differing physiological responses of passive and active sweating. Passive sweating prior to exercise is likely to affect performance more so than active sweating when the lost fluid is not replaced[2]. Therefore, a combination of fluid restriction and active sweating (preferably accompanying existing training sessions in the hours or day prior to weigh-in) may be the most pragmatic strategy to achieve AWL via dehydration. This is particularly true when the targeted magnitude is small. Passive sweating on the other hand may be best suited to situations when enough recovery time is available, and the degree of exercise required to achieve desired losses would lead to excessive muscular fatigue[2]. In these situations, combining the use of active techniques (if being used) with the wearing of additional clothing layers/sweat suits, prior to prolonged sauna sessions/ hot baths followed by wrapping oneself in towels/ thermal blankets to facilitate ongoing sweat losses are commonly used.

Reductions in sodium intake may also result in body water losses. Reductions in sodium intake during AWL are routinely used and recommended by experienced practitioners[2]. 'Water loading' is another popular method to increase fluid losses, whereby athletes consume large volumes of fluid (>100ml/kg BM) for several days, prior to fluid restriction. The rationale being that increased urine production driven by fluid consumption will persist despite fluid restriction, leading to increased fluid losses compared to restriction alone. Evidence of remains in its infancy, and this technique should be used with caution, especially as sustained large fluid intakes may increase the likelihood of hyponatremia.

Reducing fluid intake too early prior to weigh-in will simply decrease urine production, thus deciding how much fluid to drink the in the days prior to weigh-in, and when and to what degree to restrict fluid remains a bit of an 'art based on science' and decisions should be made in discussion with an experienced practitioner.

Lastly, it strongly recommended that athletes undergoing dehydration in excess of typical training losses (e.g. >3%BM), should be supervised by an experienced professional or at least a team mate or coach, as out of all the AWL strategies, dehydration poses the greatest risks to health acutely.

POST WEIGH-IN RECOVERY NUTRITION

Any competitive advantage gained from cutting weight leading into competition will only be realised by implementing a sound post weigh-in recovery plan. Priorities include rehydration and/or glycogen restoration, alongside the management of gastrointestinal distress.

REHYDRATION

Athletes should aim to rehydrate to within at least ~2% of "pre-hypohydration" BM to minimize negative performance effects[10]. Factors impeding these may include insufficient recovery time and difficulty in accurately measuring fluid losses, since acute changes in BM (traditionally used to indicate fluid losses) will likely be made up of more than just fluid. Adequate recovery time following weigh-ins is likely in sports which conduct weigh-ins the day before competition, however this may not be the case for those weighing-in the morning of competition. Therefore, in these situations, engaging in < 4% BM via dehydration to make weight is advised[2,3].

General sports nutrition recommendations suggest the consumption of 125 - 150% of the fluid deficit to compensate for continued urine losses[10,11]. In certain situations this may be difficult to implement as the true fluid deficit may be unknown and large volumes may be impractical to consume during limited recovery time. Consuming a large fluid bolus ~600 – 900 mL immediately post weigh-in plus additional boluses at regular intervals will maintain a high gastric volume, speeding gastric emptying and may prevent the need to drink closer to competition[11].

In addition to drinking a sufficient fluid volume, additional strategies should be considered.

As sweat losses contain electrolytes, (primarily sodium and chloride)[11] replacement post weigh-in is advised. Sweat sodium concentrations vary from 20-80mmol/L[10,11], making identifying the

Cutting weight is a contentious issue and presents a real health risk if poorly managed.

"optimal" concentration for a rehydration beverage difficult. However, fluid retention correlates with sodium intake from both fluids and foods (due to both electrolyte replacement and enhanced intestinal absorption[11]). Sports drinks usually contain < 30 mmol/l sodium, whereas oral rehydration solutions (ORS), commonly used to treat diarrhea or vomiting contain 50-90 mmol/l[10,11], thus making them better suited to situations when acute rehydration is the priority. Alternatively, salty snacks alongside sports drinks is another sensible option (addressing refuelling and rehydration simultaneously)[3]. Note the fact that increased energy derived from food consumed alongside fluids will slow gastric emptying[12]. Finally, fluid restriction causes a decrease in body water without the same electrolyte losses as sweating[8]. Therefore, electrolyte replacement is less important in this situation and lower sodium fluids will be well retained.

GLYCOGEN RESTORATION

Full glycogen stores are not required for most combat sports competitions, however glycogen depletion without moderate recovery will affect performance. Furthermore, BM gain (a consequence of glycogen loading)[7] may indirectly increase competitive success[1-3]. Therefore, post weigh-in recovery nutrition should include at least enough carbohydrate to fuel for competition and amounts to maximize glycogen stores only if time permits and intake does not interfere with gastrointestinal (GI) comfort or rehydration goals. As such, a wide post weigh-in recommendation of 5-10 g/kg BM is suitable[3]. Athletes with limited recovery time or those wishing to avoid potential GI discomfort can aim for the lower end, whereas those with longer recovery times or the desire to increase BM can aim at the higher end of the range. Selecting high glycaemic index carbohydrate and/or carbohydrate-rich fluids may reduce GI discomfort commonly associated with solid food consumption close to competition[3,10]. Hypertonic fluids (e.g., fluids > 10% carbohydrate) may delay gastric emptying and rehydration, affecting GI comfort[13]. As such, it may be necessary to determine which takes priority between rehydration and refuelling, as focusing on one may affect the other.

MANAGING GASTROINTESTINAL DISTRESS

Ideally, post weigh-in intake will fully recover nutritional status without causing GI distress. Decreasing fibre intake is likely the least harmful AWL strategy[2]. In contrast to depleted glycogen and dehydration, reducing gut contents is not thought to limit performance, providing energy intake remains adequate[2], and therefor does not need to be replaced. In fact, a sudden reintroduction of fiber may produce GI discomfort and affect nutrient absorption[14]. The same occurs with large fat [14]. As such fiber and fat should be limited post weigh-in as intake displaces more important nutrients and may impair performance directly and indirectly.

PRE-EVENT NUTRITION

In most sports, pre-competition nutrition involves a mere "fine tuning" of nutritional status alongside other non-dietary routine. Here is another example of the nuance with combat sport where this period often involves the aggressive reversal of weight-making efforts.

For athletes who weigh-in the day before competition, achieving recovery goals before sleep is logical, allowing competition preparation to be the focus upon waking.

Ideally, full recovery of nutritional status following AWL will occur hours before competition, allowing athletes focus on non-dietary pre-competition preparation. Post weigh-in there is a time point where priorities change from (nutritional) recovery to competition preparation (mental, physical and nutritional. For athletes weighing in the morning of competition, identifying the time point when priorities switch is harder, and likely dictated by the desire to avoid GI discomfort. When there is limited post weigh-in recovery time or when excessive AWL has occurred, balancing recovery and preparation can problematic. Accordingly, the shorter the post weigh-in recovery time, the less AWL athletes should engage in.

Key summary points

1. *Combat sports athletes routinely engage in chronic and acute body mass (BM) loss to qualify for weight divisions below their day-to-day weight*
2. *These BM loss efforts may correlate with competitive success but if extreme, may be detrimental to health and physical performance, potentially resulting in death*
3. *Due to the harmful potential of extreme measures, due diligence in nutritional prescriptions and monitoring needs to be implemented to balance the potential risks with benefits.*
4. *Moderate to substantial dehydration should be supervised and youth athletes should be discouraged from AWL*
5. *Athletes who weigh-in ≥ 12 h before competition may lose up to 10% of their BM if best practice methods are sensibly implemented in the days to week preceding weigh-in*
6. *This magnitude of acute BM loss should be reduced to ~5% if weigh-ins occur the day of competition*
7. *In addition to dehydration (the most commonly utilised method of acute weight loss), athletes should strategically implement glycogen depletion and fibre's intake restriction to minimise the required dehydration.*
8. *Purposeful and calculated recovery nutrition implemented post weigh-in is vital to minimising the negative physiological effects incurred from acute weight loss efforts*
9. *Recovery nutrition needs to be mindful of traditional pre-competition practices and consider gut comfort issues associated aggressive rehydration/fuelling*
10. *Athletes should create a weight loss and recovery plan ahead of time and rehears this prior to important competitions. Furthermore, continual evaluation and refinement of this plan should take place throughout an athlete's career.*

Carbohydrate availability pre-exercise is a well-recognized strategy to improve performance[10] thus the recommendation of ≥ 1g/kg carbohydrate in the hours before competition, in the form of easily digested, low-fat, low-fiber foods before is sensible [3,10].

Assessment of recovery requirements planning access to foods and fluids should be done ahead of time, allowing recovery to begin immediately following weigh-in. Fighters commonly select fluids in immediately (30-60 min) post-weigh-in, thus the consumption of an oral rehydration solution (ORS) may be a suitable choice for those prioritizing rehydration, whereas traditional sports drinks alongside gels, chews, candy or other high glycemic index foods provide a post weigh-in solution targeted more toward fuelling. In the second hour of recovery, athletes may wish to begin consuming solid foods. Again, carbohydrate-rich, low fiber, low fat selections are recommended and continuing fluid intake during this time is also important, but if food includes sodium-rich selections, electrolyte-containing beverages may not be required[12] and water will be sufficient. In reality, many common foods are either high in sodium and/or easy to add salt to, thus are suitable as recovery meals. When controlling the content of food is difficult and/or an athlete does not want to eat more substantial food, continuing to drink an ORS to address alongside sugar-rich snacks or sports foods will address carbohydrate and rehydration requirements. Similarly, many sports drinks are convenient choices for moderate rates of rehydration and refuelling, however, some have low sodium contents (preventing rapid rehydration), so consuming salty snacks alongside will further support fluid retention. Proactive strategies addressing rehydration and fuelling should continue until recovery is achieved (e.g., consumption of 125-150% of fluid deficit and adequate carbohydrate) or until continued consumption impacts GI comfort or competition preparation[3].

CONCLUSION

Cutting weight is a contentious issue and presents a real health risk if poorly managed. It may decrease absolute performance and negatively affect health, while paradoxically increasing competitive success. Athletes should become familiar with the associated risks or rapid weight loss and the best practice methods to manage them. Avoiding extreme magnitudes of acute weight loss (and in particular large magnitudes of dehydration) will best preserve performance and health. Athletes should develop a plan that includes familiar practices and continually evaluate and refine their AWL and recovery strategies throughout their career. For further detailed guidelines and in-depth discussion, readers are referred to existing acute weight loss[2] and recovery/pre-competition[3] review articles.

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