

**Sociotechnical Systems Analysis of Combat Sports to Advocate for Action to Reduce Rapid
Weight Loss**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this
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Introduction

In the world of combat sports, “athletes are divided into categories based on gender and body mass” (Barley et al., 2019). The purpose of the integration of the weight class system in combat sports was “to promote fair competition by matching opponents of equal stature and body mass” (Langan-Evans et al., 2011). In recent times, this system has led to many athletes participating in dangerous *weight-cuts* in order to make weight and gain a competitive edge. *Weight-cutting*, or *rapid weight loss* (RWL), is defined as the practice of weight class divided sports athletes “training at a heavier [body mass], then engaging in one or several methods to induce rapid [body mass] loss” (Brechney et al., 2019). According to research done by Barley et al., “between 60–80% of competitive combat sports athletes have reported to engage in some form of weight-cutting” in order to compete at lower weight classes (2019). Researchers have stated that many athletes that participate in the practice of RWL do so in order to gain a competitive advantage against opponents that are lighter, smaller and weaker (Franchini et al., 2012).

Athletes who perform methods of RWL in order to compete at lower weight classes constantly place their health—both physiological and psychological—at risk. The *Journal of the International Society of Sports Nutrition* published an article that highlights the adverse effects of RWL.

Several investigations have reported that athletes undergoing RWL presented decreased short-term memory, vigor, concentration and self-esteem as well as increased confusion, rage, fatigue, depression and isolation. ... [Most] studies

indicate that weight loss decreases both aerobic and anaerobic performance. While aerobic performance impairments have been attributed to dehydration, decreased plasma volume, increased heart rate, hydro electrolytic disturbances, impaired thermoregulation and muscle glycogen depletion, decreased anaerobic performance is mainly related to reduced buffering capacity, glycogen depletion and hydro electrolytic disturbances (Franchini et al., 2012).

Throughout this paper, I highlight the physiological and psychological toll that performing RWL takes on an athlete. Further, I utilize Andersen et al.'s sociotechnical system analysis of the entities and actors involved in the Hurricane Katrina disaster in order to evaluate the current system of combat sports and provide insights as to the deficiencies within the system. In this paper, I argue that the health of the athletes that compete in combat sports must take priority over their adherence to current weight class systems, and I propose a systemic solution to combat the prevalence of the practice in current competitions that preserves the integrity of the competition.

Part I: Analysis of the Physiological and Psychological Effects of Performing RWL for Competition

The use of RWL to make weight in combat sports has been widely acknowledged by the governing bodies of combat sports along with the athletes that practice it, realizing the competitive advantage gained from practicing short-term weight regulation (Pettersson et al., 2013). In recent times, athletic commissions, whose purpose

is to regulate unarmed combat contests and exhibitions, have begun taking steps towards preventing the “possible likely health risks and recent extreme cases where athletes have died as a result of rapid weight loss” (California State Athletic Commission, 2016).

Although the prevalence of the issue has been recognized by large combat sports promotions, including large *mixed martial arts* (MMA) promotions such as Bellator, the UFC, and ONE Championship, the majority of competition regulators have not adopted sufficient methods for preventing RWL. In this section, I will provide information on the methods used by athletes to induce RWL, and its impact on a combat sport’s athlete’s physiological and psychological health. Further, I will try to bridge the gap between what we know of the immediate and short-term effects RWL has on athletes and the measures that have been taken by combat sports competitions in order to deter or reduce the prevalence of the issue.

The topic of weight loss surrounding combat sports athletes has remained a key point of research amongst athletic health as well as medical health journals. Recently, the *Journal of the International Society of Sports Nutrition* published a research paper on the topic of weight loss in combat sports, evaluating its effects on athletes’ physiological and psychological health (Franchini et al., 2012). Table 1 displays the paper’s findings of the prevalence and magnitude of weight loss for these athletes.

Table 1

Weight loss prevalence and magnitude in combat sports’ athletes

Sample	Prevalence	Magnitude	Author s
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Brazilian judo (n = 145)	Males: 62.8%	Males ^a : 5.6 ± 2.2 kg	Brito et al.[10]	
		8.5 ± 4.2%		
Brazilian jujitsu (n = 155)	Males: 56.8%	Males ^a : 2.9 ± 1.5 kg		
		4.1 ± 2.0%		
Brazilian karate (n = 130)	Males: 70.8%	Males ^a : 2.5 ± 1.1 kg		
		3.6 ± 2.2%		
Brazilian taekwondo (n = 150)	Males: 63.3%	Males ^a : 3.2 ± 1.2 kg		
		4.3 ± 3.2%		
Iranian wrestling (n = 436)	62%	3.3 ± 1.8 kg (5.0 ± 2.6%)		Kordi et al.[17]
Brazilian judo (n = 822)	86% (all categories)	Most of the athletes reduced between 2–5%		Artioli et al.[5]
	89% (heavyweights excluded)			
Brazilian judo (n = 105 males and 20 females)	Males: 77.1%	Males: 4.5 ± 3.5 kg	Fabrini et al.[19]	
	Females: 55.0%	Females: 1.7 ± 0.8 kg		
USA judo (n = NR)	70–80%	NR	Horswill[20]	
Brazilian Olympic Boxing Team	100%	5.8 kg	Perón et al.[13]	
Canadian taekwondo (n = 28)	53%	NR	Kazemi et al.[11]	
	62%	2.9 ± 1.3 kg		

USA high school wrestling (n = 2352)		4.3 ± 2.3%	Kinigham and Gorenflo[21]
USA college wrestling (n = 63)	89%	5 kg	Steen and Brownell[6]
USA high school wrestling (n = 368)	70%	2.3 kg	
USA high school wrestling (n = 747)	NR	3.1 ± 2.4 kg	Tipton and Tcheng[22]

Note: This table provides data from the research published in the *Journal of the International Society of Sports Nutrition* on the prevalence of weight loss among combat sports athletes (Franchini et al., 2012).

NR = not reported; a = weight loss for the week before competition.

From the data, researchers found that high school and college wrestling experienced anywhere from 70-90% prevalence of weight loss amongst participants, Brazilian Jiu-jitsu experienced 56.8% prevalence among male athletes, and Brazilian Judo experienced 86% prevalence among all weight classes.

Athletes that perform weight cuts in order to make weight for competition use a variety of methods to do so. Research published by the *Journal of the International Society of Sports Nutrition* provides insights into the methods used by mixed-martial artists to cut weight (Park et al., 2019). It is important to note that all the data from the research was collected by self-reported methods and was limited to 92 male subjects.

Table 2 provides a report on the frequency of methods used to cut weight by the athletes that participated in the study (Park et al., 2019).

Table 2

Frequency (percent) of methods used to cut weight by MMA athletes in relation to amount of weight lost. N = Number of MMA athletes

Method	Frequency (%)	Amount of weight cut						
		0–2 lbs.	3–5 lbs.	6–10 lbs.	11–15 lbs.	16–20 lbs.	21–25 lbs.	26+ lbs.
Overall N	92	2	1	2	20	20	24	23
# of methods used M (SD)	4.27 (1.51)	0 (0.0)	2 (2.0)	5.50 (.71)	4.45 (1.19)	4.05 (1.15)	4.46 (1.59)	4.48 (1.50)
Food restriction	82.6%		100.0%	100.0%	85.0%	85.0%	79.2%	87.2%
Sauna	69.6%				75.0%	65.0%	66.7%	78.3%
Diuretics	2.2%						4.2%	4.3%
Sweat suit	59.8%				65.0%	65.0%	158.3%	56.5%
Increased training	69.6%		100.0%	50.0%	80.0%	70.0%	70.8%	65.2%
Water load	72.8%			100.0%	80.0%	70.0%	79.2%	69.6%
Vomiting or laxatives	1.1%				5.0%			
Salt bath	29.3%			50.0%	20.0%	30.0%	37.5%	30.4%

Salt load	4.3%				5.0%		8.3%	4.3%
Juice cleanse	3.3%				10.0%			4.3%
Sweet sweat	15.2%				10.0%	15.0%	20.8%	17.4%
Low carb	1.1%							4.3%
Colonic	3.3%					5.0%	4.2%	4.3%
Water restrictions	2.2%				5.0%		4.2%	
Jacuzzi or hot tub	6.5%			50.0%	5.0%		12.5%	4.3%
Other (low sodium diet)	2.2%							8.7%
Other (ketogenic diet)	1.1%							4.3%

Note: This table provides information on the methods of weight-cutting self-reported by 92 MMA athletes that participated in a study of the methods used to induce rapid weight loss and the people advising these athletes utilize the methods (Park et al., 2019).

Among the participants, popular methods reported in the paper include water-loading, food restriction, and the use of saunas and sweat suits to deplete body fluid levels.

Expanding upon the methods involving dehydration reported in the study, athletes utilized saunas, sweat suits, and hot tubs among other dehydration methods in order to induce RWL. According to the Mayo Clinic, dehydration of this magnitude may result in a “drop in blood pressure and oxygen in [their] bodies” that could be fatal if not handled properly (2019). When these athletes deplete their hydration levels, the blood

flow to their kidney drops, and may cause the kidneys to stop functioning or result in acute kidney injury (Sexton, 2018). A study performed at the *Australian Institute of Sport* utilized 22 male grapplers in order to report the physiological effects of interruptive water intake on the athlete's body (Reale et al., 2018). One result of the study was the effect it had on body mass, reporting "significant cumulative change across each successive day" of dehydration (Reale et al., 2018).

While the health risks involved with the dehydration aspect of performing these methods is clear, other physiological deficiencies and issues are caused by the same methods. A case study that was published by the *International Journal of Sport Nutrition and Exercise Metabolism* evaluated the physiological and biochemical effects that RWL had on one male MMA fighter. The overall conclusion of the study was that "extreme weight making causes relative energy deficiency, dehydration, and acute kidney injury" (Kasper et al., 2019). Among the various deficiencies discovered in the study, the researchers "observed that the athlete exhibited clear symptoms of the relative energy deficiency in sport syndrome (RED-S)" (Kasper et al., 2019). The study also reported that the subject was incapable of completing performance tests, experienced a reduction in testosterone levels, and severe dehydration levels prior to weighing in induced hypernatremia and acute kidney injury (Kasper et al., 2019).

The damage caused by these aggressive weight loss techniques is not limited to its physical impact on athletes, as it also has psychological implications as well. A study published in the peer-reviewed journal *Medicine and Science in Sports and Exercise* utilized questionnaires to analyze the eating behaviors of high school wrestlers (Dale & Landers, 1999). From the study, 36% of the subjects were classified as "at risk" on the

eating disorder inventory (EDI) during their respective seasons (Dale & Landers, 1999). Of the wrestlers who were classified as “at risk”, 62% reported answers of “always”, “often”, or “very often” when asked if they had thought of trying vomit in order to lose weight (Dale & Landers, 1999). While the percentage of athletes that were classified as “at risk” was expected to drop once the athlete’s season ended, the study helps highlight an important issue within combat sports, which is that behaviors exhibited by athletes attempting to induce RWL falls in line with patterns of behavior witnessed in people diagnosed with eating behaviors.

A lack of research has been done on the regulations and rules that promote and foster a culture that normalizes the use of RWL in order to make weight for competition. According to the research done by Barley et al., there are policies that can be put into place by the governing bodies of the competition that can help manage weight loss in combat sports (2019). Policies suggested by the research include hydration testing, reducing the amount of time given to an athlete between weighing in and actual competition, and introducing more weight classes to reduce the gap between weight classes (Barley et al., 2019). These policies, among others, can become commonplace amongst combat sports competitions, allowing for less instances of RWL used to make weight for competition, and thus, reducing amount of physiological and psychological damage taken by the athletes in their attempts to make weight.

The governing bodies of current combat sports competitions must begin reevaluating current practices in order to prevent further damage to an athletes’ physiological and psychological well-being. The weight-class system, along with weight loss regulations and monitoring are areas of which can be improved upon to help prevent

athletes from resorting to dangerous methods of weight loss. The suggestions for improvement upon regulations and policies from Barley et al.'s research lays a theoretical foundation that many combat sports competitions can use in order to begin restructuring their current policies.

Part II: Andersen et al.'s Analysis of Hurricane Katrina's Sociotechnical System Applied to RWL in Combat Sports

In the statement released by the American Society of Civil Engineers (ASCE) following Hurricane Katrina titled "What Went Wrong and Why" (Andersen et al., 2007), the writers of the statement took on the task of evaluating the sociotechnical system involved in the prevention of and recovery from damage caused by natural disasters in Louisiana. The evaluation of the sociotechnical system was used in order to propose multiple calls-to-action, or goals, based on the weaknesses and limitations discovered during their analysis of the sociotechnical system. I will apply a similar evaluation of the sociotechnical system that incorporates combat sports in order to draw out potential points of improvement that can assist in deterring the use of dangerous RWL techniques by participating athletes.

Describing Andersen et al.'s Analysis of Hurricane Katrina's Sociotechnical System and Approach to Recommending Potential Solutions

In Andersen et al.'s released statement following the disaster caused by Hurricane Katrina (2007), the statement began with an executive summary of the shortcomings that were experienced during the natural disaster, as well as some of the

contributing factors that led to the prolonged effects of the event. The executive summary provides a small list of some of the contributing factors, including the lack of interconnectedness within the construction of the hurricane protection system, the lack of public knowledge of the risks the public faced due to their location, and issues with the height of the constructed levees due to the gradually sinking state of New Orleans (Andersen et al., 2007). In the executive summary, Andersen et al. also mentioned that “no single agency was in charge of hurricane protection in New Orleans... [assigning the] responsibility for the maintenance and operation of the levees and pump stations [over] many federal, state, parish, and local agencies” (2007).

Following the executive summary in the introduction, the ASCE Hurricane Katrina External Review Panel stated the intents and purpose of the review within the introduction section. According to Andersen et al., the assessment of the catastrophic event served the purpose of discovering “what happened to the New Orleans hurricane protection system as a result of Hurricane Katrina—and why it happened” (2007). This information would help “avoid a similar catastrophe in the future—in New Orleans and in other hurricane- and flood-prone areas of the country” (2007).

The portion of the statement that addressed the analysis of the sociotechnical system began by evaluating environmental factors that enabled the storm to become as catastrophic as it had due to the geographic location of the affected area, as well as the development of the city on what is considered a sinking river area (Andersen et al., 2007). Aside from these factors, which are largely out of the control of the different actors and entities responsible for preparing against the disaster, the analysis goes in-depth about the construction of the hurricane protection systems, which was done over

the span of four decades (Andersen et al., 2007). This system, according to the report, was “a disjointed agglomeration of many individual projects that were conceived and constructed in a piecemeal fashion” (Andersen et al., 2007). The sociotechnical system analysis discovered that the engineers and authorities in place failed to consider dynamic factors, such as the gradually sinking ground, when constructing the physical hurricane protection systems. The authorities also failed to sufficiently communicate the potential threat to people’s livelihoods and lives that the storm presented, making it difficult to adequately evacuate and protect those who inhabited the city (Andersen et al., 2007).

Through the analysis of the development of the hurricane protection systems, from an organizational and cultural standpoint, the ASCE was able to recommend ten “Call-To-Action” items that detailed different goals that would help alleviate the potential hazard of deficiencies across the development of natural disaster protection systems. The first call-to-action, “keep safety at the forefront of public priorities”, involves the recommendation that “all responsible agencies in New Orleans... should re-evaluate their policies and practices to ensure that protection of public safety, health, and welfare is the top priority for the infrequent but... devastating impacts from hurricanes and flooding” (Andersen et al., 2007). Other calls-to-action include communicating “the risks to the public and decide how much risk is acceptable”, a recommendation to “rethink the whole system”, and “put someone in charge” (Andersen et al., 2007).

In summary, the ASCE’s evaluation of the sociotechnical components of the hurricane protection systems in New Orleans allowed the group to release a set of goals and guidelines as to potential next steps to help prevent a reoccurrence of the catastrophe that was Hurricane Katrina and its mishandling.

Breakdown of the Sociotechnical Components of Combat Sports

The blanket term “combat sports” represents any sport where opponents strike each other with different parts of the body as part of the competition (“Combative sports definition, n.d.). Due to the range of different sports that fall within this category, my sociotechnical system analysis will be focused on professional mixed-martial arts in order to provide a more succinct evaluation of the factors that contribute to RWL across all sports encompassed by the term.

From a technological perspective of the sociotechnical system, there are a few components worth noting. Currently, athletes can be evaluated for physical well-being and hydration levels through hydration testing. This protocol involves “determining an athlete’s body fluid balance” to determine their current hydration levels (Jardine, 2018). As of today, hydration testing is not a standard across each promotion, and is only enforced based on the rules set forth by each individual state athletic commission. Apart from hydration testing, there are methods of rehydration that are currently prohibited by the different governing bodies within the sport. One such method of rehydration is rehydration through IV, which provides “essential hydration, diluting medications, and [facilitates] the delivery of vitamins throughout the body” (“What’s in our IV Drip Treatments”, n.d.). Many have drawn attention to the necessity of such rehydration methods in order to help sufficiently restore an athlete’s hydration levels after weigh-ins and prior to actual competition.

At the organizational level, there are different entities that are in charge of promoting competition, developing the rules of the sport, and the creation and enforcement of drug-use policies. The promotional entities within the system are in

charge of promoting the popularity of a competition and ensuring that ticket sales for these competitions are sufficient. Currently, all United States based promotions, such as Bellator and the UFC, adhere to the Unified Rules of MMA set forth by the Association of Boxing Commissions and Combat Sports (ABCCS). This association is in charge of determining the weight classes that are recognized for competition and determining the rules for the athletes during competitive events. Alongside the ABCCS are state athletic commissions, which “[regulate] professional and amateur boxing, kickboxing and mixed martial arts throughout the State by licensing all participants and supervising the events” (California State Athletic Commission, n.d.). These athletic commissions also play a role in requiring athletes to adhere to their set of drug-usage policies, and rehydration methods. Promotions, such as the UFC, utilize the United States Anti-Doping Agency (USADA) in order to enforce more stringent drug testing policies, while promotions, such as Bellator, solely require their athletes to adhere to the respective state commission’s drug policies that the competition takes place in.

At the cultural level, there are many different components that dictate the way an athlete trains, the methods they use to lose weight for competition, and overall attitude towards competition. To begin, there is the athlete, who is the actual competitor within these competitions. From one aspect, there are teams of individuals that an athlete hires in order to prepare them for competition. This team is comprised of coaches for different martial arts styles, conditioning, and maintaining sufficient nutrition. In terms of this team, an athlete is heavily reliant on their guidance in decisions that have to do with both the preparation for competition, as well as the weight-loss component of the sport. Many athletes utilize their teams in order to assist them during their weight-cuts for

competition, requiring them to be physically present as they cut weight in order to maintain their safety during the weight cut and after weighing in. An athlete relies on this team to assist them even after weighing in in order to help rehydrate prior to competition, and to observe them for any physical ailments as a result of the weight cut.

From another aspect, there is a form of pride that athletes within mixed-martial arts take in describing their weight cutting methods and the amount of weight they lost prior to competing. Many athletes have revealed this information through interviews and social media, and a large majority attribute their decisions to lose weight or “go down a weight class” to the advice of their coaching staff and nutritionist in order to have a better chance of winning. This is also prevalent in the commentary provided during mixed-martial arts competitions as well as the media surrounding competitions. In an article released by the *Bleacher Report*, for example, the author identifies three different athletes that should consider moving down a weight class, noting things such as the athlete being “woefully undersized” for their current weight class or that opponents have been able to best them “by simply being a bigger physical force” (Ryder, 2016).

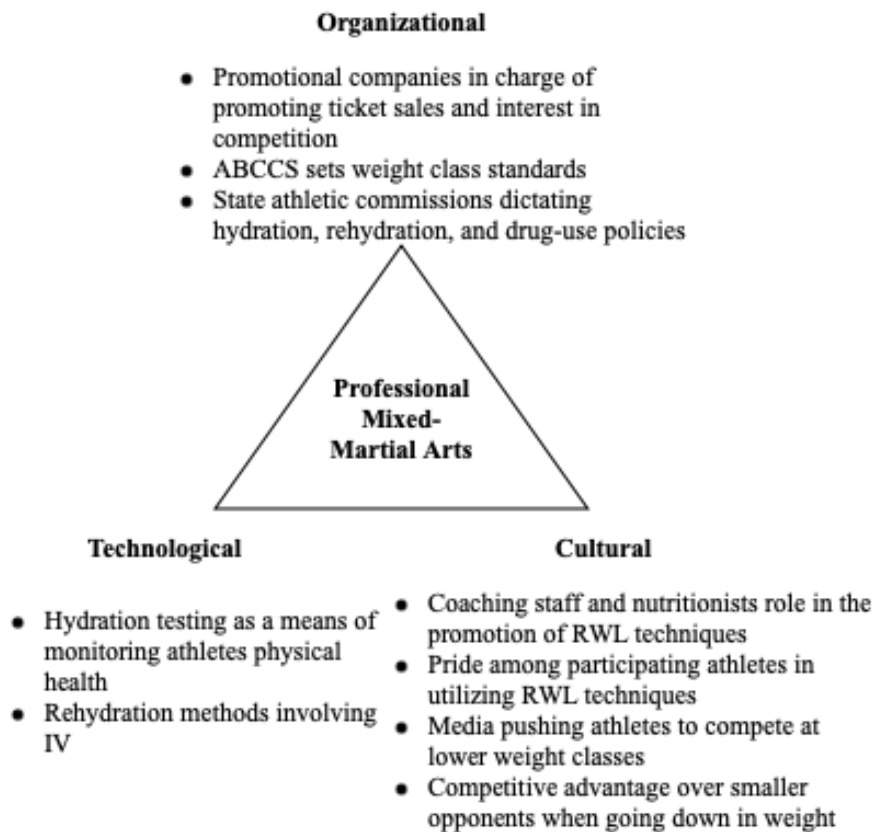
In summary, the sociotechnical system of mixed-martial arts is comprised of many different entities and actors that play a role in the prevalence and persistence of RWL as an issue within the sport. The decentralized nature of the governing bodies (i.e. athletic commissions, promotions), the culture surrounding weight-cutting, and the limitations in the implementation of current technological solutions have allowed the problem to continue and remain largely unaccounted for.

Part III. Systemic Decentralization, Cultural Aspects, and a Lack of Solutions

From the previous sections detailing information regarding the prevalence of RWL in combat sports, and an evaluation of the sociotechnical system surrounding one particular combat sport, there are areas of improvement within the system as a whole in order to help deter the pervasiveness of RWL. Figure 1 provides an illustration of the technological, organizational, and cultural components of the sociotechnical system for professional mixed-martial arts, as described in the previous section.

Figure 1

Sociotechnical System Map of Mixed-Martial Arts



Note: This is a sociotechnical system map of the different components involved in mixed-martial arts.

Key Findings

Based on the sociotechnical system map described in Figure 1, the decentralized nature of the policies and standards surrounding hydration testing makes it difficult for the solution to be implemented systemwide. As previously mentioned, there currently is no industry standard as to the hydration policies that different promotional companies have decided to adhere to. There are five major athletic commissions in the United States, each with their own set of policies that competitors must adhere to prior to competing within each respective state. As mentioned previously in this paper, certain state athletic commissions, such as the California State Athletic Commission (CSAC), have only recently begun shedding light on the issue of dehydration as it pertains to RWL. Currently, the CSAC is the only major athletic commission that has instilled policies regarding hydration testing, requiring athletes to undergo a hydration test during their pre-fight physical in order to ensure their health and safety prior to competing (Raimondi, 2016). The lack of a standard of hydration testing across all competitions within mixed-martial arts makes it difficult to deter athletes from partaking in dangerous dehydration methods to induce RWL. In the event that an athlete successfully makes weight utilizing these methods, the practice is only reinforced and encouraged, adding to the argument of its effectiveness in making weight.

The culture surrounding weight-cutting in mixed-martial arts, as well as all combat sports, can be both toxic and dangerous to participating athletes. At every level of combat sport, there are athletes that participate and encourage the use of dangerous

dehydration methods in order to make weight for competition. This is only exacerbated by people who currently advise participating athletes, such as their coaching staff and nutritionists. These actors within the network act as motivators for athletes to continue practicing these dangerous techniques to induce RWL. From an organizational standpoint, the promotional companies and current governing bodies do not do enough to educate the coaching staffs and nutritionists on the dangers of these techniques. This is mostly due to athletes hand-picking their nutritionists and current health advisors. Both the promotional companies and the state athletic commissions must do a better job, based on the sociotechnical system map, in order to both educate and enforce safer practices in the reduction of weight for competition. This can come through educational courses on the health risks associated with RWL, and the development of a standard that any coach or nutritionist hired by participating athletes must adhere to prior to being recognized as official members of their team. Aside from educating the direct advisors to these athletes, the organizations involved must also begin educating athletes on the long-term health risks, as well as the increased risk of head trauma, associated with RWL. This, in turn, would help begin promoting an entire culture of athletes, trainers, and coaches that are well-informed about the issue, and thus reduce the popularity of the practice as a subject within the media and in conversations between competitors.

There must be a reevaluation of the different rehydration methods approved across all organizations. As mentioned previously, methods such as rehydration by IV have largely been banned by the current governing bodies of the sport. Entities, such as USADA and the CSAC, both have banned the use of rehydration through IV in order to “protect clean sport and athlete health and safety”, noting the use of IVs in order to

“change blood test results, mask urine test results (by dilution) or administering prohibited substances” (USADA, 2018). The inherent physical dangers associated with dehydration can only be mitigated through proper rehydration prior to competition, otherwise placing athletes at an increased risk of long-term health problems. Although the use of IVs may be considered extreme, it is one of the most effective methods for athletes to replenish their bodies with the proper vitamins and minerals after performing any form of dehydration to make weight. Perhaps the risk of an athlete utilizing such methods in order to circumvent positive drug test results is too high a price for the competitions to pay in order to allow the practice to continue, but alternative solutions that are as effective have not currently been recommended or instilled. Therefore, the current governing bodies should make a better attempt to provide athletes methods of proper rehydration after weighing in. A possible suggestion for this issue would be to increase the length of time between an athlete weighing in for competition, and the actual event itself. This would allow athletes a large time window to properly rehydrate, rest, and prepare for their own competition.

Conclusion

Rapid weight loss techniques utilized in combat sports remain a common practice and threat to the health and safety of participating athletes. The results of a sociotechnical system analysis of one particular combat sport demonstrates that attempted solutions at prevention and mitigation of the effects of the practice have largely been unsuccessful due to the decentralized nature of the current governing bodies within the sport, a lack of educational standards provided to both the athlete and their coaching staff, as well as current prohibited methods of rehydration after weighing in.

The analysis should be utilized in order to recognize the role that actors within the system have played in the development and progression of RWL, as well as the role that the larger entities within the system have played in allowing the practice to continue. The analysis could additionally serve as a source of information for suggestions as to how to improve the current system in order to assist in the deterrence of the dangerous practices.

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