

## **Author's reply to Davis et al: "It is time to ban rapid weight loss from combat sports"**

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Dear Editor,

In our opinion piece [1], we argued that rapid weight loss (RWL) meets WADA's criteria for a method or substance being hazardous to an athletes' health. Dr Davis [2] disagrees, stating that the literature is not clear on the negative impact of RWL on health-related parameters. However, no evidence to the contrary is presented. It seems to be undisputed that RWL imposes a significant stress to many bodily systems, ultimately leading to increased risk of several adverse effects that may vary from mild transient events (e.g., headaches) to death, albeit in the most extreme of cases. RWL has been a matter of concern for the medical community for over 40 years and its potential hazards have been recognized by at least three medical associations [3-6]. The list of potential negative effects associated with RWL is extensive, with some of the most severe and hazardous being: 1) severe dehydration [7-9]; 2) hormonal imbalance [10-12]; 3) increased muscle damage [12] which, in extreme cases, may lead to rhabdomyolysis and death [6]; 4) increased risk of injury during competition [13]. Therefore, RWL cannot be considered safe.

Dr Davis criticises our reference choice stating that "*a number of papers (...) are not even sport specific.*" [2], an argument repeatedly used in his letter. However, the flaw in this logic is obvious, since the physiological effects of RWL will not depend on any "sport specificities". In fact, the physiological impact of RWL and its health consequences will largely depend upon, 1) the amount of weight lost; 2) the time taken to reduce weight; 3) the methods used to reduce weight; and 4) individual intrinsic factors, such as pre-existent conditions, susceptibility to potential complications and medical history. It is unclear why Dr Davis suggested that the physiological effects would differ within the context of a specific sport. In fact, several of these symptoms (i.e., dehydration and hyperthermia) may be aggravated further when combined with intensive training regimen, thereby rendering this argument invalid. Therefore, we refute that

we need “sport specific” studies to understand the physiological effects of severe dehydration, severely reduced energy intake, heat stress and a combination of these. These are solid foundations of physiology that have been known for decades; numerous high-quality and well-controlled studies have demonstrated that dehydration and heat stress (both conditions resulting from fluid restriction and induced sweating) can profoundly impact homoeostasis and elicit hazardous responses (one example can be found in Green et al. [14]). If these foundations are to be challenged, then strong scientific evidence that dehydration, heat stress and prolonged fasting (alone or in combination) are safe and free of adverse and hazardous effects should have been presented.

Dr Davis then states that “*reductions in plasma volume and increases in blood viscosity*” are not health risks per se, and that “*studies in combat sports (...) have shown that although they change they stay within the ‘normal’ range*”. [2]. Blood viscosity has been shown to be an independent risk factor for stroke and ischaemic heart disease [15-17] with haematocrit being one of the main determinants of blood viscosity. More recently, Yang et al. [18] showed increased aggregation of red blood cells in taekwondo athletes following ~5% of rapid, but not gradual, weight loss. Both blood viscosity and red cell aggregability are prothrombotic factors. Moreover, the fact that a few studies have shown haematocrit to be within normal range after a 5% weight loss does not rule out the possibility that larger weight reductions, which are fairly common in combat sports, could lead to more dangerous blood viscosity profiles. Although this is yet to be demonstrated in a scientific investigation, cases of combat athletes dying in saunas due to stroke [19] are suggestive that the prothrombotic blood profile following more extreme weight loss is a cause for concern.

In a similar comment, Dr Davis also says that “*impaired cardiovascular efficiency (...) is also not a health risk per se*” and that “*the paper referenced assesses the effect of dehydration in hyperthermic endurance athletes, of which combat sports athletes are neither.*” [2]. We disagree that impaired cardiovascular efficiency is not a health risk since it is nothing more than a consequence of all hazardous cardiovascular changes elicited by RWL. Again, the physiology of dehydration and hyperthermia is not “sport specific” and suggesting otherwise is contrary to basic physiological concepts. Furthermore, to suggest that combat athletes would not fall into a “hyperthermic” state like other athletes is not supported by scientific evidence.

In his next point, Dr Davis argues that there is no combat sport specific evidence to support that heat stress and dehydration can lead to hyperthermia [2]. The lack of a combat sport specific study to demonstrate that these athletes experience hyperthermia does not exclude the large possibility that dehydration and heat stress caused by RWL will likely lead to hyperthermia. Athletes lose significant amounts of weight through dehydration and the use of various methods that induce thermal stress. Hyperthermia is a very likely consequence or, at the very least, a risk. It seems clear that a study showing hyperthermia in combat athletes is not mandatory to assume that they are at risk. Although Dr Davis implies that combat athletes, for whichever reason, could respond differently to dehydration and heat stress than other athletes, no evidence to support these assertions were provided.

Dr Davis then suggests that RWL may not compromise immune function. However, instead of broadening the discussion with contrasting evidence, Dr Davis has chosen to criticise our choice of reference. To strengthen our argument, we wish to highlight a further seven studies which show impairment of selected parameters of immune function following RWL [20-26]. Furthermore, an increased incidence of upper respiratory tract infection due to RWL was

reported in at least two studies [24,25], and confirmed by data from our own group which is currently under review.

In relation to the effects of RWL on bone metabolism, Dr Davis correctly states that “*the judo athletes in the study did not suffer from any bone loss.*” [2]. We agree that Proteau et al. [27] did not show a decrease in bone mass; however, their data did indicate that bone metabolism shifted towards bone resorption rather than bone formation.

Next, Dr Davis implies that the risk of death by RWL is negligible. In his words, “*If 84 % of combat sports athletes are making-weight [8–11], and given the millions of such athletes in the world and the number of competitions being undertaken, the small number of deaths reported over so many years would appear to suggest that making weight has an inconsequential effect on mortality in combat sports.*” [2]. Firstly, at no point did we try to portray these deaths as a consequence of a “typical” 5% weight loss. What we did mention, and herein wish to reinforce, is that death is a possible, albeit extreme, result of RWL in combat sport. Secondly, it is misleading to judge RWL risks based on the “typical” 5% weight loss, since this implies that losing >15% is a rare and isolated case that only occurred with those unfortunate wrestlers who died. The literature indeed demonstrates that 5% is an approximation of the average weight loss for many combat athletes, but it is important to note that the range of weight loss is high. Consequently, a substantial proportion of athletes lose amounts of body mass even greater than the same ~15% that led those wrestlers to lose their lives [9-19].

Re-examining our data from a RWL survey in judo athletes [28], we observed that ~12% of the sample (n=664, heavyweights and children below 15 years of age excluded) had lost more than 10% of their body mass to compete. More alarmingly, ~1.5% of the athletes reported to have lost more than 15% of their body mass on at least one occasion. Although this figure may seem negligible for some, extrapolation of these numbers would suggest that thousands of judo athletes worldwide are likely risking their lives by undertaking RWL of more than 15%. If we further explore other combat sports, then these number may only rise. In mixed martial arts (MMA), for example, studies indicate that a strikingly high number of athletes undertake large weight reductions (above 10% of body weight) by means of extreme procedures on a regular basis [9-19]. Thus, despite the occurrence of death lying on the unlikelier side of the equation, this does not mean it should be overlooked.

Also, death is not the sole risk that an athlete is taking when decide to engage in RWL. By analogy, if this logic is correct, most (if not all) drugs that are banned by WADA should be considered for reclassification, since the incidence of deaths caused by their use is low. However, the majority of these drugs can cause a number of unwanted adverse effects, as we know that RWL can. It is also true that an athlete does not need to reduce much more than the supposedly “acceptable” 5% of weight before they may experience a number of symptoms that may affect their health and well-being. To mention just one study assessing such symptoms, Alderman et al. [32] reported that 47% of the surveyed wrestlers reported headache, 44% dizziness, 42% nausea, 22% hot flushes, 20% nosebleeds, 18% feverish (not due to sickness), 9% disorientation and 4% racing heart rate as RWL-related symptoms. It is worth noting that in this study, the majority of these symptoms were evoked by rapid weight losses within the “acceptable” 5% range.

Finally, in addition to 5 reported deaths associated with RWL [19,29], more anecdotal reports of very severe adverse effects attributed to RWL can be found in lay media<sup>1</sup>, further suggesting that extreme and severe adverse events are not so uncommon, but perhaps underreported. Hence, not only does the literature demonstrate that RWL can cause adverse physiological symptoms, it is clear that death is a possible consequence. Therefore, we reinforce our statements that 1) RWL imposes an unnecessary and potentially harmful stress to many bodily systems and is accompanied by several adverse effects; 2) a considerable number of athletes are at the extremes of RWL and therefore putting themselves at risk of serious health-risks to compete and, therefore, 3) RWL should not be permitted by regulatory agencies.

Dr Davis then states he is surprised that we “*have tried to convince the readers that making-weight is beneficial to performance*” [2]. We believe Dr Davis might be mistaking the differences between performance in exercise capacity tests and performance in an actual competition. As stated in our original paper, we are aware that most studies show that RWL either decreases selected physical capacities or does not influence them. Most studies show that RWL is not detrimental to performance when athletes have a minimum of ~3h to recover from RWL; we have shown similar findings in two studies conducted by our group [30,31]. Since competitions in most combat sports allow athletes to recover for 3h or longer periods, it is clear that the lack of effects on physical capacities may become a true competitive advantage against smaller and weaker opponents in a lighter weight division. If an athlete is able to reduce weight and face smaller opponents without having any decrement in physical capacities, then the competitive advantage is fully realised. After all, in combat sports size matters.

Furthermore, the true competitive advantage that a combat athlete may have by facing smaller opponents may overcome small detrimental effects (if any) on physical capacities such as strength, aerobic or anaerobic fitness. In fact, no study assessing physical capacities in laboratory settings will ever be able to fully elucidate how RWL can affect actual competitive performance. However, the advantages in weight and size are enough to conclude that RWL provides an unfair advantage, regardless of the advantage being realised in a true victory or not. This unfair advantage is such that most athletes are obliged to reduce weight in order to re-establish equality. In that sense, it is not surprising that the magnitude of RWL or rapid weight gain (after weigh-in) was associated with competitive success in at least four cross-sectional studies [28,32-34], two of them being large-scale [28, 32]. Although not all studies reported that weight loss is associated with competitive success, none reported that weight loss is associated with less success, rendering RWL to be either beneficial or not harmful to competitive performance. Other than the physical advantages, there is evidence that RWL may also confer mental advantage [35]. The potential is, therefore, clear.

In his final paragraph, Dr Davis [2] concludes that “*it is far from time to ban making-weight in combat sports*”, finally arguing that such implementation could not be feasible and, instead, we need more research to guide us in taking appropriate decisions. We agree that current literature is not conclusive on many aspects of RWL and it is clear that further research is required (as it is in almost every topic in science). However, the adverse effects, health risks and potential competitive advantages brought about by RWL are clear enough in our opinion, as per our previous arguments. Violation of the spirit of the sport is a subjective matter, but this

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<sup>1</sup> We suggest consulting the following webpage where there is a compilation of severe consequences of RWL in combat sports <https://combotsportslaw.com/2014/09/03/yes-athletes-have-been-hurt-from-weight-cutting-in-mma/> (accessed 23 February 2017)

is also true for all substances and methods that make WADA's list. In our view, RWL clearly violates the spirit of sport, for a number of reasons:

- 1) an athlete who reduces weight for weigh-in will normally refeed and rehydrate before competing, meaning that, by the time of competition, he/she will be above the weight limit. This obviously undermines the whole purpose of weight divisions;
- 2) since RWL is so widespread, any athlete wanting to compete in his/her "natural" weight division will face opponents that are often much larger and stronger, placing this athlete at a size/strength disadvantage. Therefore, an athlete wanting to compete against opponents of similar sizes will have no option other than to also engage in RWL procedures. This was made obvious by a combat athlete interviewed in the study by Petterson et al. [35] who said "*(...) if I wouldn't cut weight and everyone else does it, then I would be in trouble.*" This benefits those willing to take the risks and discomforts associated with RWL to the detriment of those unwilling to compromise their health by undertaking these stressful strategies;
- 3) the goal of combat sports in general is to find the best combination of technique, athleticism and strategy, with discrepancies caused by body sizes corrected by the use of weight classes. As RWL escalates, another capability begins to play an important role in combat sports' outcomes, namely the ability to reduce weight without having physical performance affected. This clearly is not a goal of any sport, nor is it of combat sports.

Although implementing a ban on RWL would not be without difficulties, as would the implementation of any ban on a particular method or substance, this does not mean it should not be banned, although how to implement a ban on RWL is beyond our scope. In our opinion, RWL remains a harmful method with potential to enhance competitive performance in combat sports and, because it violates the spirit of sport, it should be immediately banned from combat sports.

## Compliance with Ethical Standards

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### Conflicts of interest

Guilherme G Artioli, Bryan Saunders, Rodrigo Iglesias and Emerson Franchini declare that they have no conflicts of interest relevant to the content of this reply.

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