

Effects of caloric restriction on anthropometrical and specific performance in highly-trained university judo athletes

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A - Study Design; B - Data Collection; C - Statistical Analysis; D - Data Interpretation; E - Manuscript Preparation

Abstract

Purpose: The purpose of this study was to determine the ultimate body mass, performance, and nutritional characteristics of the Algerian judo junior athletes, and also analysing the impact of nutritional intakes on stabilising Weight loss according to special performance of judo athletes.

Material: Twenty-one male university athletes (aged: 21.45 ± 1.32 ; height: 1.81 ± 0.45 m; and body mass: 73.9 ± 4.1 kg) participated in this study during a period of stabilising Weight loss before and after 15 days of caloric restriction. Athletes were submitted to anthropometrical measurements and performed the Special Judo Fitness Test. Values for nutrient intakes were obtained from a 15 day food record kept during a training camp period of Weight maintenance and after a 15-day caloric restriction.

Results: caloric restriction resulted in significant decreases in body mass (73.73 ± 2.1) and performance. However, Special Judo Fitness Test index increased significantly (14.00 ± 1.75) during caloric restriction in comparison to stabilising Weight loss.

Conclusions: Exercise and caloric restriction lead to determine the ultimate Weight and physical performance. The present study provides baseline nutritional data that can be used in the prescription of individual training programs for university judo Athletes.

Keywords: weight loss, nutritional, physical performance, judo.

Introduction

Nutrition and Dietary is recommended as an important part of sport performance for young athletes [1]. Nutrition is increasingly recognized as a key component of optimal sporting performance, with both the science and practice of sports nutrition developing rapidly [2], Sports nutrition enhances athletic performance by decreasing fatigue and the risk of disease and injury; it also enables athletes to optimize training and recover faster [3]. To optimize performance, young athletes need to learn what, when and how to eat and drink before, during and after activity [1]. Hector and Phillips [4] noted that high quality Weight loss is often of importance to elite athletes in order to maintain their muscle (engine) and shed unwanted fat mass, potentially improving athletic performance

Judo is an intermittent combative sport requiring technical, tactical, and psychological skill that creates great muscle-strength and -power demands on both the upper and lower body [5]. Judo competitions are divided into weight classes [6]. However, most athletes reduce their body weight in a few days before competition in order to obtain a competitive advantage over lighter opponents [7,8], and no study investigated a Weight loss higher than 5% of athlete's body mass [9]. To achieve fast weight reduction, athletes use a number of aggressive nutritional strategies so many of them place themselves at a high health-injury risk [4]. Judo, as a combat sport, involves open and complex skills [10,11], presenting irregular intervals of effort and pause, and characterized as an intermittent activity [5,12,13]. However, few athletes maintain their daily body weight within the limits

of their class before competition [14].

Weight loss is one of the most commonly used strategies by athletes in combat sports to gain a winning edge in their targeted weight classes [15]. The loss of large amounts of body mass in a short time is extremely harmful to the body; it can reduce muscle strength [16] also demonstrate that the exercise-induced hyperthermia and dehydration in the present experiments had only minor effects on the neuromuscular performance. In addition, reductions in renal blood fluid and the volume of liquid filtered by the kidneys [17,18]. Additionally, these physiological alterations can decrease anaerobic capacity, an important determinant of overall performance in judo [19]. A questionnaire was designed to evaluate rapid Weight loss patterns of competitive judo players and to assess its validity and reliability [20]. In conclusion, the questionnaire showed good validity and reliability and could be used accurately to assess Weight loss patterns of judo players. Suzuki et al [21] concluded that weight reduction, consisting of both intense exercise and energy restriction, might possibly cause both an increase in oxidative burst activity and decrease in neutrophil phagocytic activity in judo athletes females. Additionally, studies investigating the effects of Weight loss on performance used at laboratory-based techniques [9], which may not reflect the demands of real judo combat heart rate [22,23]. Therefore, a judo-specific performance test (Special Judo Fitness Test, SJFT), which is more representative of judo movements than laboratory tests, has been proposed as a valid and reliable measure of performance in judo athletes [24,25]

Hypothesis: This study set out to test the hypothesis that body mass, performance, and nutritional characteristics of

nutritional intakes could stabilise Weight loss according to special performance of judo athletes.

Purpose: of this study was to determine the ultimate body mass, performance, and nutritional characteristics of the Algerian judo junior athletes, and also analysing the impact of nutritional intakes on stabilising Weight loss according to special performance of judo athletes.

Materials and Methods

Participants

Twenty-one healthy male university judo competitors took part in this study (mean (\pm SD); aged: 21.5 ± 0.7 years; height: 1.81 ± 0.45 m; and body mass: 75.0 ± 2.8 kg) participated in the study after receiving a comprehensive explanation of the procedure. This study protocol was in accordance with the Helsinki Declaration for human experimentation [28] and was approved by the scientific institute of sports ethics committee. The participants were also selected based on their mean period of practising judo was 9.2 ± 2.1 years. They competed in categories between -66 kg and -73 kg. Based on the results of a self-reported questionnaire, no subject had been treated with any experienced acute illness from infection during the first three months. Subjects reported no sleep disorder and did not consume any alcoholic beverages and none of them was taking any medication. All judokas participated in official judo competitions during this year and trained for 20-22 hours per week.

Study Design

During the week before the experimentation, participants came to the training GYM several times to become fully familiarized with the procedure and tests involved so as to minimize learning effects during the experimentation. Athletes participated in two experimental test sessions. The first was a baseline condition in which athletes were taking a normal diet (baseline). The second was a condition of caloric restriction for 15 days; participants reduced their energy intake by 4.5 MJ/day (CR). At the end of each phase athletes performed the SJFT at the same time of day (10 a.m.). All experimental study were scheduled during a period with no official competitions.

At the end of each phase body mass, percent body fat, fat mass, fat-free mass, and body water were recorded using bioelectrical impedance scale to the nearest 0.1 kg (Tanita, Tokyo, Japan) calibrated in accordance with the manufacturer's guidelines by one trained technician. The body mass index was then calculated according to [29]. Following this, duplicate measurements were taken with participants standing and wearing only briefs, as recommended by the guidelines. The average of these two measurements was used for the final analysis. Moreover, the heart rate was monitored using Automatic Blood Pressure [30]. During the experimental period, participants were required to maintain their habitual physical activity and to avoid exhausting physical efforts 24 h before each test time.

Assessment of Dietary Intake

Nutritional assessment was carried out every 7 days to assess the energy intake of the subjects (i.e., fat, protein, and carbohydrate). Each athlete received recommendations needed to properly complete the food diaries. The athletes completed a self-administered validated Rapid Weight loss Questionnaire [13]. Thus, they detailed the food and beverages consumed during the 3 days prior to sampling. We asked athletes to maintain their normal diet during the study period (control period). Values for nutrient intakes were obtained from a food diary for a holding period of body mass and dietary restriction after 15 days. The plan was to carry out dietary restriction according to the report from [31]. The Weight loss methods used by athletes in this study appear to be generally used [32]. The records were analyzed by a nutritionist using a computerized nutrition system, the NUTRISOFT- BILNUT [Vers. 2.01, Paris, France] [33].

Special Judo Fitness Test (SJFT)

This test was proposed by Sterkowicz (1995). Briefly, three athletes of similar body mass are needed to perform the Special Judo Fitness Test: 1 participant (tori) is evaluated, and 2 other individuals receive throws (ukes). The tori begins the test in a position between the 2 ukes who are standing 6 m away from each other. On a signal, the tori runs to one of the ukes and employs a throwing technique called ippon-seoi-nage. The tori then immediately runs to the other uke and completes another throw. The athlete must complete as many throws as possible within the test time.

The Special Judo Fitness Test is composed of 3 periods (15 s, 30 s, and 30 s) separated by 10 s recovery intervals. Performance is determined by the total number of throws completed during each of the 3 periods. Heart rate is measured immediately after and 1 minute after the test and the following index is calculated as follows:

$$\text{Index} = \frac{\text{final HR (bpm)} + \text{HR 1 min after the end of the test (bpm)}}{\text{total number of throws}}$$

where Final HR is the heart rate measured immediately after the test, HR 1 min is the heart rate measured 1 min after the test, and throws represent the total number of throws executed during the three sets.

Statistical Analyses

The Levene test was used to check the homocedasticity, and the Shapiro-Wilk test was used to test the normality of data, and given these assumptions were confirmed parametric statistics were used. Data are reported as mean \pm SD, and 95% confidence intervals (95%CI) of the difference. Energy intake, anthropometric parameters, performance of SJFT, and heart rate were tested by a paired Student's t-test. The level of statistical significance was set at 5%. Cohen's d was calculated as post caloric restriction mean minus baseline mean divided by baseline standard deviation and classified according to Rhea (2004) for highly trained athletes (trivial < 0.25; small = 0.25 to 0.50; moderate = > 0.50 to 1.0; large = > 1.0).

Results

There was a significant effect of caloric restriction on body mass ($t_{20} = 4.21$, $p < 0.001$, 95%CI difference = 0.6 to 1.8, $d = 0.43$ [small]), body mass index ($t_{20} = 4.25$, $p < 0.001$, 95%CI difference = 0.51 to 1.50, $d = 0.41$ [small]), body water ($t_{20} = 8.61$, $p < 0.001$, 95%CI difference = 2.2 to 3.6, $d = 1.00$ [moderate]), fat free mass ($t_{20} = 4.78$, $p < 0.001$, 95%CI difference = 0.6 to 1.4, $d = 0.31$ [small]), energy intake ($t_{20} = 16.35$, $p < 0.001$, 95%CI difference = 1223 to 1580, $d = 5.32$ [large]), carbohydrate intake ($t_{20} = 14.67$, $p < 0.001$, 95%CI difference = 138 to 184, $d = 4.12$ [large]), protein intake ($t_{20} = 22.75$, $p < 0.001$, 95%CI difference = 57 to 69, $d = 5.70$ [large]), and fat intake ($t_{20} = 55.12$, $p < 0.001$, 95%CI difference = 136 to 146, $d = 14.00$ [large]), with a decrease during caloric restriction compared to baseline. However, no change between periods was detected for body fat ($t_{20} = 0.95$, $p = 0.352$, 95%CI difference = -0.4 to 1.0, $d = 0.13$ [trivial]).

The caloric restriction resulted in significant decrease in the number of throws during A ($t_{20} = 4.18$, $p < 0.001$, 95%CI difference = 0.4 to 1.1, $d = 0.80$ [moderate]) and total ($t_{20} = 3.05$, $p = 0.001$, 95%CI difference = 0.5 to 2.9, $d = 0.37$ [small]) compared to the baseline, while increasing final heart rate ($t_{20} = -6.71$, $p < 0.001$, 95%CI difference = -14 to -8, $d = -1.82$ [large]), heart rate 1 min after the test ($t_{20} = -8.26$, $p < 0.001$, 95%CI difference =

-9 to -5, $d = -0.87$ [moderate]) and index of the Special Judo Fitness Test ($t_{20} = -3.77$, $p = 0.001$, 95%CI difference = -2.00 to -0.58, $d = -0.50$ [moderate]) in the period of caloric restriction compared to baseline. No changes were observed concerning the number of throws in sets B and C.

Discussion

Our main aim in this study was to address the almost total lack of research evidence on stabilising Weight loss of judo athletes. We have done so by directly observing and reporting on the daily work of Twenty-one healthy male judo competitors, with special attention to their high judo training, caloric restriction whereby these assessments made themselves knowledgeable for all practical purposes, as dictated by their specific performance.

The main findings of the present study were that a 15-day caloric restriction program decreased judo athletes' body mass, body water, body mass index, free fat mass and judo-specific performance, specifically decreasing the number of throws during set A and total during the Special Judo Fitness Test, while increasing heart rate (after and 1-min after this test) and the index in this test (which indicates worse performance). The study [22] assess effectiveness of training's construction and of micro-cycle in total and detect in due time the trend to development

Table 1: Anthropometric parameters and daily nutrient consumption at baseline and caloric restriction periods (values are mean and standard deviation; $n = 21$).

Anthropometric parameters	Baseline	caloric restriction
Body mass (kg)	75.0 ± 2.8	73.73 ± 2.1*
Body water (kg)	42.7 ± 2.9	39.8 ± 3.6*
Body mass index (kg/m ²)	27.8 ± 2.4	26.8 ± 3.1*
Body fat (kg)	9.1 ± 2.2	8.8 ± 2.5
Free fat mass (kg)	66.8 ± 3.2	65.8 ± 3.6*
Energy intake (kcal/day)	3675 ± 263	2274 ± 216*
Carbohydrates (g/day)	425 ± 39	264 ± 25*
Protein (g/day)	150 ± 11	87 ± 7*
Fat (g/day)	233 ± 10	92 ± 6*

* Significant difference from baseline ($p < 0.001$).

Table 2: Performance and heart rate responses during the Special Judo Fitness Test in judo athletes during normal diet (baseline) and after caloric restriction (values are mean and standard deviation; $n = 21$).

SJFT test parts	Baseline	Caloric Restriction
A (rep)	5 ± 1	4 ± 1**
B (rep)	12 ± 2	12 ± 1
C (rep)	11 ± 2	10 ± 2
Total throws (rep)	28 ± 5	26 ± 3**
Final heart rate (bpm)	178 ± 6	189 ± 8**
Heart rate 1min after (bpm)	163 ± 8	170 ± 8**
Special Judo Fitness Test index	12.72 ± 2.60	14.00 ± 1.75**

A = first set of the Special Judo Fitness Test (15s); B and C = second and third, respectively, sets of the Special Judo Fitness Test (30s each); ** Significant different from baseline ($p < 0.01$); ** significant different from baseline ($p < 0.001$).

of over-loading and failure of adaptation. As planned the caloric restriction program reduced total energy intake by 38%, resulting in decreased carbohydrate (38%), protein (42%) and fat (41%) intakes. However, this diet did not change body fat.

Despite the fact that athletes reduced only 1.7% of their body mass, which is in the range recommend for gradual Weight loss, performance was negatively affected. This is contrast to the observation that up to 5% rapid Weight loss did not affect judo-related performance [18]. Our findings are also different from those reported by [34] when comparing wrestlers and judo athletes submitted to gradual ($5.0 \pm 0.4\%$ Weight loss in three weeks) or rapid Weight loss ($6.0 \pm 0.6\%$ in 2.4 days). These authors reported no change in 30-m sprint and 1-min Wingate performances, suggesting that the athletes analysed coped well with both types of diets.

The ultimate goal is to identify a healthy body Weight that the athlete can maintain for most of the year, while minimizing the amount of Weight that needs to be lost for competition.

We hypothesized that the Weight loss would result in more detrimental effects on both caloric restriction and judo performance test. [16] investigate the effect of liquid losses occurring in training sessions during the competition period on some biochemical values of the male Judokas competing in the U18 category. The results of the performance tests support the fact that the duration of the intervention was important for changes in performance test. [33] Study results are equivocal when it comes to performance. Some studies report unchanged or improved performance in certain tests after Weight loss in athletes, despite loss of IBM [34] There are several risks related to rapid Weight loss and Weight cycling, such as depressed immune activity [35–37], [38] indicate that supplying HMB promotes advantageous changes in body composition and stimulates an increase in aerobic and anaerobic capacity in combat sports athletes.

In this study, the caloric intake during the caloric restriction period leads to a significant decrease in body Weight ($2.2 \pm 0.23\%$), which was in accordance with other athletes in combat sports [39]. The loss of body Weight represented an average of 2.6 kg in absolute (Table 1). In this context, Artioli *et al.* [20] observed a reduction in body Weight after a 5-day Weight loss period when compared to control values. Likewise, Mendes *et al.* [40] showed 5% reduction in body Weight after a 5-day Weight loss period. The most frequent methods used by judo players were increased exercise, restricted food ingestion, training in heated rooms, gradual dieting, and fluid restriction [7]. In accordance with several reports our results showed that rapid Weight loss affects negatively performance in judo athletes [41]. We herein argue that rapid Weight loss clearly meets all three criteria and, therefore, should be banned from the sport [42], Considering that these health-threatening methods are more commonly used by lower level athletes, specific education programs should be directed to them [43]. In a recent review, Fagerberg [44] discussed the negative

consequences of restricting calories too severely, [45] this review summarises guidelines for athletes and coaches for manipulating BM and optimising post weigh in recovery period, also to achieve better health and performance outcomes across the different Olympic combat sports.

The ultimate goal is to identify a healthy body Weight that the athlete can maintain for most of the year, while minimizing the amount of Weight that needs to be lost for competition.

Although other studies analysed the effects of body Weight reduction on performance among combat sport athletes [14,42,43], it is worth noting that the present study was designed to determine the appropriate Weight. The Weight of an athlete can maintain without dieting is typically higher than their competition Weight [46], The results of our study allowed us to conclude that stabilising Weight loss was not a good strategy to optimise judo athletes performance. Finally, more research is needed concerning the long-term effects of stabilising Weight loss on physical and cognitive performance of judo athletes as recommended by [9], especially those investigating female judo athletes. also An individualized and well-planned gradual and safe Weight loss program under the supervision of a team of coaching staff, athletic trainers, sports nutritionists, and sports physicians is recommended. In addition, the sport dietitian can help make daily meal plans, address nutrition and sport supplements and health issues, and make sure the athletes is fuelled for their sport. This will improve their ability to design individualized and realistic Weight-management programs.

This study was limited by the reduced sample size of the population studied and the participants' characteristics as Olympic athletes, as well as the duration of the study (2weeks).

Another Two main limitations can be identified in our study: the absence of a control group submitted to a judo training and the lack of control concerning athletes' nutritional intake before the study. The use of control group in training camp is difficult, because athletes are submitted according to their performance result process. Additionally, some authors consider that there would be "ethical problems with restricting a particular treatment to elite athletes" [47], athletes were not using any supplementation and were oriented to keep the nutritional training diet throughout the study.

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Conflict of interest

The authors declare no conflict of interest.

References

- Purcell L, Canadian Paediatric Society, Paediatric Sports and Exercise Medicine Section. Sport nutrition for young athletes. *Paediatrics & Child Health*, 2013;18:200–2. <https://doi.org/10.1159/000350263>
- Burke LM, Meyer NL, Pearce J. National Nutritional Programs for the 2012 London Olympic Games: a systematic approach by three different countries. *Nestle Nutr Inst Workshop Ser.* 2013;76:103-20. <https://doi.org/10.1159/000350263>
- Hoch AZ, Goossen K, Kretschmer T. Nutritional requirements of the child and teenage athlete. *Phys Med Rehabil Clin N Am.* 2008;19:373-398. <https://doi.org/10.1016/j.pmr.2007.12.001>
- Hector A, Phillips SM. Protein Recommendations for Weight Loss in Elite Athletes: A Focus on Body Composition and Performance. *Int J Sport Nutr Exerc Metab.* 2017;1-26.
- Ohya T, Takashima W, Hagiwara M, Oriishi M, Hoshikawa M, Nishiguchi S, et al. Physical Fitness Profile and Differences Between Light, Middle, and Heavy Weight-Class Groups of Japanese Elite Male Wrestlers. *Int J Wrestl Sci*, 2015;5:42- 6. <https://doi.org/10.1080/21615667.2015.1030006>
- Artioli GG, Franchini E, Nicastrò H, Sterkowicz S, Solis MY, Lancha AH. The need of a weight management control program in judo: a proposal based on the successful case of wrestling. *J Int Soc Sports Nutr.* 2010;7:15. <https://doi.org/10.1186/1550-2783-7-15>
- Artioli GG, Gualano B, Franchini E, Scagliusi FB, Takesian M, Fuchs M, et al. Prevalence, magnitude, and methods of rapid weight loss among judo competitors. *Med Sci Sports Exerc.* 2010;42:436-42. <https://doi.org/10.1249/MSS.0b013e3181ba8055>
- Langan-Evans C, Close GL, Morton JP. Making Weight in Combat Sports. *Strength Cond J*, 2011;33: 25. <https://doi.org/10.1519/SSC.0b013e318231bb64>
- Fortes LS, Costa BDV, Paes PP, Cyrino ES, Vianna JM, Franchini E. Effect of rapid weight loss on physical performance in judo athletes: is rapid weight loss a help for judokas with weight problems? *Int J Perform Anal Sport*, 2017;17:763-73.
- Kons RL, Dal Pupo J, Ache-Dias J, Detanico D. Female Judo Athletes' Physical Test Performances Are Unrelated to Technical–Tactical Competition Skills. *Perceptual and Motor Skills*, 2018;125:802–16. <https://doi.org/10.1177/0031512518777586>
- Belkadi A, Othman B, Mohamed S, M BH, Gleyse J, Adel B, et al. Contribution to the Identification of the Professional Skills Profile of Coaches in the Algerian Sport Judo System. *Int J Sports Sci.* 2015;5:145-50.
- Branco BHM, Massaça LM, Andreato LV, Marinho BF, Miarka B, Monteiro L, et al. Association between the Rating Perceived Exertion, Heart Rate and Blood Lactate in Successive Judo Fights (Randori). *Asian J Sports Med.* 2013;4:125-30. <https://doi.org/10.5812/asjrm.34494>
- Marcon G, Franchini E, Jardim JR, Barros Neto TL. Structural analysis of action and time in sports: judo. *J Quant Anal Sport*, 2010;6:1– 15. <https://doi.org/10.2202/1559-0410.1226>
- Abdelmalek S, Chtourou H, Souissi N, Tabka Z. Caloric Restriction Effect on Proinflammatory Cytokines, Growth Hormone, and Steroid Hormone Concentrations during Exercise in Judokas. *Oxid Med Cell Longev.* 2015;2015:809492. <https://doi.org/10.1155/2015/809492>
- NgQi X, ChoeYee X, Karppaya H, ChaiWen J, Ramadas A. Rapid weight loss practices among elite combat sports athletes in Malaysia. *Malays J Nutr*; 2017;23:199-209.
- Ftaïti F, Grélot L, Coudreuse JM, Nicol C, Coudreuse JM. Combined effect of heat stress, dehydration and exercise on neuromuscular function in humans. *Eur J Appl Physiol*, 2001;84:87- 94. <https://doi.org/10.1007/s004210000339>
- Melin B, Jimenez C, Savourey G, Bittel J, Cottet-Emard JM, Pequignot JM, et al. Effects of hydration state on hormonal and renal responses during moderate exercise in the heat. *Eur J Appl Physiol.* 1997;76:320-7. <https://doi.org/10.1007/s004210050255>
- Franchini E, Lira FS, Julio UF, Antunes BM, Agostinho MF, Shiroma SA, et al. Cytokine, physiological, technical–tactical and time structure responses in simulated judo competition. *International Journal of Performance Analysis in Sport* 2018;18:595–608. <https://doi.org/10.1080/24748668.2018.1501993>
- Filaire E, Maso F, Degoutte F, Jouanel P, Lac G. Food Restriction, Performance, Psychological State and Lipid Values in Judo Athletes. *Int J Sports Med*, 2001;22:454- 9. <https://doi.org/10.1055/s-2001-16244>
- Artioli GG, Iglesias RT, Franchini E, Gualano B, Kashiwagura DB, Solis MY, et al. Rapid weight loss followed by recovery time does not affect judo-related performance. *J Sports Sci*, 2010;28:21- 32. <https://doi.org/10.1080/02640410903428574>
- Suzuki M, Nakaji S, Umeda T, Shimoyama T, Mochida N, Kojima A, et al. Effects of weight reduction on neutrophil phagocytic activity and oxidative burst activity in female judoists. *Lumin J Biol Chem Lumin.* 2003;18:214-7. <https://doi.org/10.1002/bio.727>
- Villar R, Gillis J, Santana G, Pinheiro DS, Almeida ALRA. Association Between Anaerobic Metabolic Demands During Simulated Brazilian Jiu-Jitsu Combat and Specific Jiu-Jitsu Anaerobic Performance Test. *J Strength Cond Res*, 2018;32:432.
- Slimani M, Znazen H, Sellami M, Davis P. Heart rate monitoring during combat sports matches: a brief review. *International Journal of Performance Analysis in Sport*, 2018;18:273–92. <https://doi.org/10.1080/24748668.2018.1469080>
- Artioli GG, Gualano B, Coelho DF, Benatti FB, Gailey AW, Lancha Jr AH. Does sodium-bicarbonate ingestion improve simulated judo performance? *Int J Sport Nutr Exerc Metab*, 2007;17:206– 217. <https://doi.org/10.1123/ijsnem.17.2.206>
- Miarka B, Del Vecchio FB, Franchini E. Acute effects and postactivation potentiation in the special judo fitness test. *J Strength Cond Res*, 2011;25:427– 431. <https://doi.org/10.1519/JSC.0b013e3181bf43ff>
- World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA.* 2013;310:2191-4. <https://doi.org/10.1001/jama.2013.281053>
- Houcine A, Ahmed A, Saddek Z. Designing a Software to Count the Body Composition and Somatotype and its Role in Pursuing the Morphological State of Spotsmen. *AASRI Procedia*, 2014;8:38- 43. <https://doi.org/10.1016/j.aasri.2014.08.007>
- Elliott KE, McCall KL, Fike DS, Polk J, Raehl C. Assessment of Manual Blood Pressure and Heart Rate Measurement Skills of Pharmacy Students: A Follow-Up Investigation. *American Journal of Pharmaceutical Education*, 2008;72:60. <https://doi.org/10.5688/aj720360>
- Artioli GG, Scagliusi F, Kashiwagura D, Franchini E, Gualano B, Junior AL. Development, validity and reliability of a

- questionnaire designed to evaluate rapid weight loss patterns in judo players. *Scand J Med Sci Sports*. 2010;20:e177-187. <https://doi.org/10.1111/j.1600-0838.2009.00940.x>
30. Shimizu K, Aizawa K, Suzuki N, Masuchi K, Okada H, Akimoto T, et al. Influences of Weight Loss on Monocytes and T-Cell Subpopulations in Male Judo Athletes: *Journal of Strength and Conditioning Research*, 2011;25:1943–50. <https://doi.org/10.1519/JSC.0b013e3181e4f9c6>.
 31. Abdelmalek S, Souissi N, Takayuki A, Hadouk S, Tabka Z. Effect of Acute Maximal Exercise on Circulating Levels of Interleukin-12 during Ramadan Fasting. *Asian J Sports Med*, 2011;2:154- 60. <https://doi.org/10.5812/asjasm.34751>
 32. Fogelholm GM, Koskinen R, Laakso J, Rankinen T, Ruokonen I. Gradual and rapid weight loss: effects on nutrition and performance in male athletes. *Med Sci Sports Exerc*. 1993;25:371-7. <https://doi.org/10.1249/00005768-199303000-00012>
 33. Garthe I, Raastad T, Refsnes PE, Koivisto A, Sundgot-Borgen J. Effect of Two Different Weight-Loss Rates on Body Composition and Strength and Power-Related Performance in Elite Athletes. *International Journal of Sport Nutrition and Exercise Metabolism* 2011;21:97–104. <https://doi.org/10.1123/ijsnem.21.2.97>.
 34. Smith M, Dyson R, Hale T, Hamilton M, Kelly J, Wellington P. The Effects of Restricted Energy and Fluid Intake on Simulated Amateur Boxing Performance. *International Journal of Sport Nutrition and Exercise Metabolism*, 2001;11:238–47. <https://doi.org/10.1123/ijsnem.11.2.238>
 35. Imai T, Seki S, Dobashi H, Ohkawa T, Habu Y, Hiraide H. Effect of weight loss on T-cell receptor-mediated T-cell function in elite athletes. *Med Sci Sports Exerc*. 2002;34:245-50. <https://doi.org/10.1097/00005768-200202000-00011>
 36. Kowatari K, Umeda T, Shimoyama T, Nakaji S, Yamamoto Y, Sugawara K. Exercise training and energy restriction decrease neutrophil phagocytic activity in judoists. *Med Sci Sports Exerc*. 2001;33:519-24. <https://doi.org/10.1097/00005768-200104000-00003>
 37. Matthews JJ, Nicholas C. Extreme Rapid Weight Loss and Rapid Weight Gain Observed in UK Mixed Martial Arts Athletes Preparing for Competition. *International Journal of Sport Nutrition and Exercise Metabolism*, 2017;27:122–9. <https://doi.org/10.1123/ijsnem.2016-0174>
 38. Durkalec-Michalski K, Jeszka J, Podgórski T. The Effect of a 12-Week Beta-hydroxy-beta-methylbutyrate (HMB) Supplementation on Highly-Trained Combat Sports Athletes: A Randomised, Double-Blind, Placebo-Controlled Crossover Study. *Nutrients*, 2017;9:753. <https://doi.org/10.3390/nu9070753>.
 39. Lopes-Silva JP, Felipe LJC, Silva-Cavalcante MD, Bertuzzi R, Lima-Silva AE. Caffeine Ingestion after Rapid Weight Loss in Judo Athletes Reduces Perceived Effort and Increases Plasma Lactate Concentration without Improving Performance. *Nutrients*, 2014;6:2931- 45. <https://doi.org/10.3390/nu6072931>
 40. Mendes SH, Tritto AC, Guilherme JPLF, Solis MY, Vieira DE, Franchini E, et al. Effect of rapid weight loss on performance in combat sport male athletes: does adaptation to chronic weight cycling play a role? *British Journal of Sports Medicine*, 2013;47:1155–60. <https://doi.org/10.1136/bjsports-2013-092689>
 41. Khodae M, Olewinski L, Shadgan B, Kinningham RR. Rapid Weight Loss in Sports with Weight Classes: *Current Sports Medicine Reports*, 2015;14:435–41. <https://doi.org/10.1249/JSR.0000000000000206>
 42. Artioli GG, Saunders B, Iglesias RT, Franchini E. It is Time to Ban Rapid Weight Loss from Combat Sports. *Sports Med*, 2016;46:1579- 84. <https://doi.org/10.1007/s40279-016-0541-x>
 43. da Silva Santos JF, Takito MY, Artioli GG, Franchini E. Weight loss practices in Taekwondo athletes of different competitive levels. *J Exerc Rehabil*, 2016;12:202- 8. <https://doi.org/10.12965/jer.1632610.305>
 44. Fagerberg P. Negative Consequences of Low Energy Availability in Natural Male Bodybuilding: A Review. *International Journal of Sport Nutrition and Exercise Metabolism*, 2018;28:385–402. <https://doi.org/10.1123/ijsnem.2016-0332>
 45. Reale R, Slater G, Burke LM. Individualised dietary strategies for Olympic combat sports: Acute weight loss, recovery and competition nutrition. *Eur J Sport Sci*. 2017;17:727-40. <https://doi.org/10.1080/17461391.2017.1297489>
 46. Manore MM. Weight Management for Athletes and Active Individuals: A Brief Review. *Sports Med Auckl Nz*, 2015;45:83- 92. <https://doi.org/10.1007/s40279-015-0401-0>
 47. Atkinson G, Nevill AM. Selected issues in the design and analysis of sport performance research. *J Sports Sci*, 2001;19:811-27. <https://doi.org/10.1080/026404101317015447>

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