ORIGINAL ARTICLE

Biochemical indicators and systemic reaction times in male judo competitors during regular and pre-competition conditioning periods

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B Data Collection
C Statistical Analysis
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Abstract

Background and Study Aim: Weight control and exercise measures are integral to preparing for judo competitions. As such, a good understanding of these two areas is key to doing well in competitions, but until now, no research has thoroughly addressed them. The aim of this study was knowledge about biochemical, muscular and neural indicators during regular and pre-competition conditioning training periods of the male judo athletes (at least the rank of first dan and over 10 years practice).

Material and Methods: Sixteen judo competitors participated in this study. Blood components as analysed through samples, muscular and neural response times and body composition variables were examined. Food and water intake was also recorded. Comparisons were drawn, and conclusions were made comparing samples and data from regular and pre-competition conditioning periods.

Results: A comparison of water and caloric intake during practice between regular and pre-competition training periods showed no significant differences. Blood samples from the pre-competition sample set showed higher concentrations of the blood components analysed. Quicker muscular contraction and neural response times were recorded during pre-competition training when compared to those from regular season training.

Conclusions: Improved performance resulted from competitors' reduced liquid intake and exercise intensity Biochemical, muscular and neural data may assist coaches and athletes in assessing their physical condition in a way that could support better training and competition outcomes.

Keywords: conditioning • physical performance • weight loss

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INTRODUCTION

Judo matches are categorised as either weight class or open weight. There are 7 weight classes, and because competitors in the same class likely share similar physical characteristics, it is important for competitors to be in optimal physical condition to perform well in competitions. Competitors generally begin to lose weight rapidly around two weeks prior to competing in order to be placed in an optimal weight class. Maintaining strength and agility while simultaneously reducing caloric intake is key to competitive success [1, 2].

The combination of strength and technical skill needed to compete in judo successfully are developed using three broad exercise types. *Uchikomi* focuses on calibrating throwing techniques. *Nagekomi* focuses on movement accuracy, and *randori* simulates competition and, as such, is highly intense [3]. The level of intensity in *randori* is highly variable because of variations between competitors with respect to competitors' techniques and physical power. Previous research analysing the effects of the physical intensity of combined *uchikomi* technical manoeuvres on lactate levels and biochemical data have been conducted [4]. To the authors' knowledge, however, studies investigating the combined effects of weight reduction and *randori* drills on hydration, biochemical variables, and muscular and neural response times have not been carried out.

There is literature documenting reduced physical performance such as after doing sit-ups and increased anoxia of judo competitors after rapid weight loss. Until now, however, the impact of performing *randori* drills after reduced caloric intake on neural and muscular response times has not been carried out. In competitions, judo competitors must react quickly both offensively and defensively. Thus, neural and muscular response times are directly related to winning in competitions.

Competitors generally attempt to lose weight to qualify for specific weight categories in the time just before competitions. In recent times, some complications from this process have resulted; for example, dehydration from competitors' attempts to lose weight and overexertion during training. Ideally, coaches could manage this weight-loss process. However, best practices have not been established, in part, due to a lack of research [5].

The current study addresses this research gap. It analyses conditioning methods and how they affect those physical attributes that have a direct influence on competition outcomes. This research may inform coaching methods for competitors who need to lose weight prior to competing. This research is meant to support coaches and athletes in improving conditioning regimens and integrating natural weight reduction methods with conditioning in regular and pre-competition training.

The aim of this study was knowledge about biochemical, muscular and neural indicators during regular and pre-competition conditioning training periods of the male judo athletes (at least the rank of first dan and over 10 years practice).

MATERIAL AND METHODS

Blood test results, neural and muscular response times, body composition variables, and food and liquid intake were recorded and compared via statistical analysis to identify variances between those samples taken in regular training time periods and those preceding competitions.

Experiment day and its schedule

Blood sampling and other data collection procedures were performed during the summer season in Japan. Specifically, the pre-competition collection was done ten days prior to the competition in late August 2017 and, for regular conditioning collection, 40 days before the competition in mid-July, 2017. The training room temperature was set at 20 degrees Celsius prior to training commencement and increased to 25 degrees Celsius during training in order to facilitate competitors' weight loss (the sample and data collection timing are presented in Figure 1).

Subjects

Sixteen university male judo competitors over age twenty and at least the rank of first *dan* participated in the study. The average participants' age was 20.0 and the average amount of time as a judo practitioner was over 10 years. Participants expressed written consent to take part in this research.

The conditioning regimen

The competitors followed the conditioning regimen as directed by their university judo club. This primarily consists of *uchikomi*, or standing

Dan (dan'i) – a term used to denote one's technical level or grade. In ***jūdō***, the "***dan***" ranks start at shodan (1- ***dan***) and go up to the highest grade of ***jūdan*** (10- ***dan***) [12].

Uchi-komi (uchikomi) – repetition of basic technique in kendo and judo training [12].

Nagekomi – repetitive throwing practice.

Randori – sparring in judo in which both participants practice attacking and defending [12].

Tachi-waza (tachiwaza) – judo throwing techniques executed from a standing position. These include ***te-waza*** (hand techniques), ***koshi-waza*** (hip techniques), and ***ashi-waza*** (foot and leg techniques) [12], including also sub classification ***sutemi-waza*** (rear-fall and side-fall judo throws; synonym – "dedication throws").

Body composition – athlete's predisposition in terms of the proportion of active mass and inactive mass in the body.

Body weight loss – a reduction of the total body mass. In combat sports, it is used for preparation to start in a lower weight category.

Neural ***adjective*** **–** relating to a nerve or the nervous system [13].

Reaction time ***noun*** the interval of time between the application of a stimulus and The first indication of response [13].

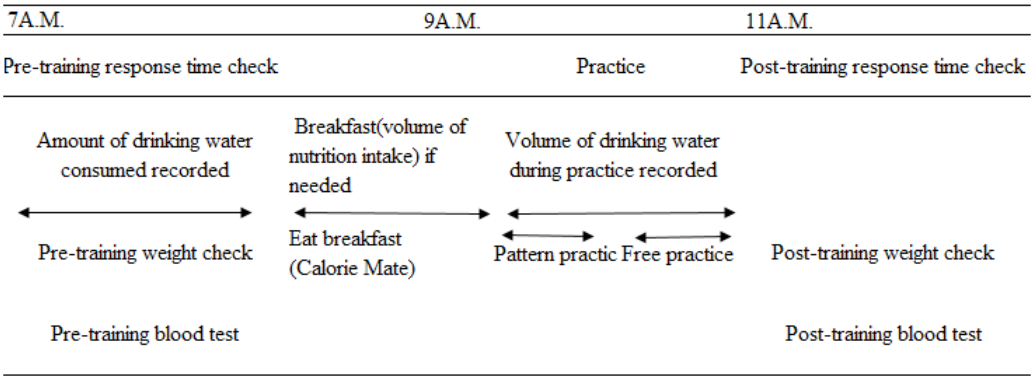

Figure 1. Data-collection schedule

Table 1. Conditioning regimen.

Order	Practice menu	Practice time/ number of repetitions
1	Warming up (physical exercise rotational motion)	
2	*Uchikomi* (throwing techniques)	100 times
3	Increased speed *uchikomi*	20 sec×5 times
4	Throwing drills	5 times×3 sets
5	Pattern drill of groundwork techniques	4 mins×7 times
6	Free practice of groundwork techniques	6 mins×5 times, 5 mins×5 times
7	Free practice of standing throws	6 mins×5 times, 5 mins×5 times
8	Cooling down exercise (stretching and physical exercise)	

technique drills, and *randori*, or competition simulation drills. The *randori* drills include *tachiwaza*, or standing techniques, and *newaza*, or groundwork techniques. These exercises are meant to develop competitors' judo skill and physical strength and are common practice in Japan (Table 1).

Measurement items

Body composition level

Body Composition Analyzer (Biospace) was used to measure the following body composition variables: weight, body fluid volume, muscle mass, lean mass, body fat mass, and body fat as a percentage.

The volume of water and nutrition intake

Food and water intake from breakfast prior to and during practice was recorded. Breakfast consisted of mineral water and Calorie Mate (Ohtsuka). Research participants were free to consume food and water at breakfast and during practice as they wished.

Blood test

Participants did not eat after 9:00 p.m. on the night before blood samples were taken. These were taken within one hour of awakening and before breakfast. Post-workout samples were taken within 30 minutes of exercise completion. Both sample sets were promptly centrifuged after coagulation, and the serum was stored in a separate lidded tube.

The following blood components were measured with a LABOSPECT 008 (Hitachi High-Technologies Corporation): albumin (Alb: improved BCP method), creatinine (Cre: enzymatic method), creatine kinase (CK), sodium (Na: ion selective electrode method), potassium (K: ion selective electrode method), magnesium (Mg), and uric acid (UA: enzyme method).

Reaction time

Reaction time was measured as simple reaction time and selective body reaction time, which was measured by having participants squat jump on a

force plate and calculated using the whole body reaction time measurement program (JumpRT 2, DKH Corporation). Simple reaction time tests were performed by randomly presenting research participants with either a red light, signalling for the participant to jump, or blue light which signalled for the participant to remain standing. The lights were shown randomly a total of 10 times; the red light was shown 6 times and the blue light 4 times. Go/No-go test using light stimulus was conducted for selective reaction time. Of the six jump signals given, the maximum and minimum response times were discarded, and the remaining four times were averaged in both simple and selective body reaction tests. Systemic reaction time was calculated as a combination of neural response time and muscle contraction time. Neural response time is the time between presentation of a red light and pressure application on the plate representing the participant's body weight and an additional 5%, signifying the participant was reacting to the signal. Muscle contraction time is represented by the end of the neural reaction time until the participants' feet leave the plate. These two figures were then added, with the sum result being the systemic reaction time.

Statistical analysis

Excel spreadsheet software (Microsoft) was used to calculate the average and standard deviation (±) of the data recorded before and after practices. T-tests were performed to determine variations in data are drawn pre and post workouts done on the same day and regular season conditioning versus pre-competition conditioning. The statistical significance level was set at $p<0.05$ for all analyses.

RESULTS

Body composition level

Pre-competition training data show that weight, body fat mass, and body fat percentage significantly decreased after practice, while fluid body volume, muscle mass and lean mass significantly increased after practice. Regular training period data show that weight, body fat mass, and body fat percentage significantly decreased after practice, while body fluid volume, muscle mass, and lean mass increased, but not significantly after practice. No differences between pre and post-practice body composition levels between data drawn from regular training and pre-competition training time periods (Table 2).

The volume of drinking water and nutrition intake

Comparisons made of food and water intake between regular training and pre-competition

Table 2. Body composition level data (mean, standard deviation) from regular season training and pre-competition workouts of male judo athletes (n = 16).

Variable	Regular season training period			Competition period		
	before practice	after practice	variation	before practice	after practice	variation
Weight (kg)	82.48 ±16.26	**81.84** ±16.2*	0.63 ±0.91	81.46 ±15.67	**80.76** ±15.54**	0.7 ±0.53
Body fluid volume (kg)	49.16 ±6.89	49.43 ±6.54	0.20 ±0.80	48.1 ±6.63	**48.79** ±6.39**	0.69 ±0.68
Muscle mass (kg)	63.28 ±8.83	63.67 ±8.40	0.39 ±1.00	62.03 ±8.54	**62.93** ±8.24**	0.9 ±0.83
Lean mass (kg)	66.84 ±9.33	67.24 ±8.90	0.39 ±1.05	65.52 ±9.06	**66.41** ±8.76**	0.89 ±0.86
Body fat mass (kg)	15.63 ±8.35	**14.6** ± 8.41**	1.03 ±0.96	15.94 ±7.73	**14.35** ±7.94**	1.6 ±0.74
Body fat percentage (%)	17.98 ±6.17	**16.74** ±6.44**	1.24 ±1.2	18.67 ±5.59	**16.78** ±6.19**	1.9 ±1.03
Drinking volume (ml)			138.125 ±52.47			119.65 ±23.82
Meal amount (g)			537.5 ±294.4			497.19 ±181.78
Calorie intake (kcal)			500.0 ±273.86			462.5 ±169.1

* $p<0.05$**$p<0.01$ vs. before practice

Table 3. Blood components levels data (mean, standard deviation) from regular season training and pre-competition workouts of male judo athletes (n = 16).

Variable	Regular season training period			Competition period		
	before practice	after practice	variation	before practice	after practice	variation
ALB (g/dL)	4.69 ±0.17	4.52 ±0.28	0.18 ±0.32	4.81 ±0.32	**5.13** ±0.26**	**0.32** ±0.19††
Cre (mg/dL)	0.9 ±0.15	0.91 ±0.16	0.01 ±0.07	0.98 ±0.14	**1.05** ±0.14**	**0.08** ±0.04†
CK (u/L)	412.25 ±424.45	**489.25** ±468.19**	77 ±63.77	371.94 ±265.31	**436.88** ±278.05**	64.93 ±53.08
UA (dL)	6.47 ±1.07	**6.23** ±1.19*	-0.24 ±0.39	7.16 ±1.18	7.28 ±1.14	**0.12** ±0.22†
Na (%)	141.63 ±0.99	**132.88** ±4.57**	8.75 ±4.32	141.35 ±1.06	141.26 ±1.08	**0.09** ±1.28††
K (mmoL/L)	4.28 ±0.31	4.11 ±0.26*	0.18 ±0.24	4.04 ±0.37	**4.29** ±0.36**	**0.25** ±0.33††
Mg(ug/dL)	2.01 ±0.1	**1.95** ±0.11*	0.06 ±0.08	2.03 ±0.14	2.03 ±0.13	0.001 ±0.07

* p<0.05 ** p<0.01 vs. before practice; † p<0.05 †† p<0.01 vs. non-competition period

Table 4. Body reaction times data (mean, standard deviation) in both regular season training and pre-competition workouts of male judo athletes (n = 16).

Variable before practice		Regular season training period			Competition period		
		after practice	variation	before practice	after practice	variation	
Simple response time(sec)	Neural response time	0.19 ±0.03	**0.20** ±0.02*	0.011 ±0.016	0.20 ±0.03	**0.18** ±0.02*	**0.014** ±0.02††
	Muscular contraction time	0.19 ±0.02	0.19 ±0.02	0.005 ±0.013	0.18 ±0.02	0.18 ±0.02	0.00006±0.013
	Systemic response time	0.37 ±0.03	**0.39** ±0.03**	0.016 ±0.019	0.38 ±0.04	0.36 ±0.03	**0.015** ±0.029††
Selective response time(sec)	Neural response time	0.26 ±0.03	0.27 ±0.03	0.006 ±0.029	0.27 ±0.04	**0.25** ±0.03*	0.018 ±0.0306
	Muscular contraction time	0.19 ±0.02	0.20 ±0.03	0.004 ±0.015	0.18 ±0.01	0.19 ±0.02	0.0013 ±0.016
	Systemic response time	0.45 ±0.03	0.46 ±0.04	0.01 ±0.025	0.45 ±0.05	0.43 ±0.04	**0.017** ±0.035†

* p<0.05 ** p<0.01 vs. before practice; † p<0.05 †† p<0.01 vs. non-competition period

training periods show that intake during the pre-competition period was less, but not significantly so.

Blood sampling

Alb, Cre, CK, and K significantly increased post-practice in the samples taken during pre-competition training. UA, Na, K, and Mg significantly decreased, and CK significantly increased post-practice in the samples taken during regular training. Comparison of pre and post-practice data taken from pre-competition training shows significantly higher levels of Alb, Cre, UA, Na and K than those of the regular training period (Table 3).

Reaction time

Nervous response times of both simple and selective responses were significantly quicker after the practice in the pre-competition period.

Nervous response time and systemic response time in simple response significantly slower after the practice on the test-day apart from the competition. Comparison of pre and post-practice data reveals that nervous response times and systemic response times in simple response, and systemic response time in selective response were significantly quicker in pre-competition training than in regular training (Table 4).

DISCUSSION

Considerations regarding the body composition variables

Data representing pre-competition conditioning was taken 7 days prior to the competition weigh-in. This coincides with the period that most competitors attempt to lose weight so that they are optimal places in weight categories. Data from pre and post-training in the pre-competition period show significantly lower weight, fluid body volume, muscle mass, and lean mass than during the regular conditioning period. Participants attempted to lose weight by limiting their daily liquid intake. On pre-competition training days, it is likely that participants deliberately decreased their water and food intake to qualify for lower weight classes. However, body fluid volume increased after practice during both regular season and pre-competition training. Participants ingested sufficient amounts of water to compensate for perspiration and to quench their thirst during workouts. In this study, participants were told that they could freely drink water during practice.

The data shows a decrease in body fat mass after practice on the day before the competition. Weight loss methods and an intentional increase in aerobic activity result in a basal metabolic rate increase. An unintended side effect of rapid weight loss is a loss of muscle mass due to improper conditioning methods. Consideration of proper weight-loss methods, particularly those preceding competitions is necessary, with coaches instructing competitors on scientifically-sound methods of losing weight.

Consideration from blood components

UA, Na, K, Mg significantly decreased in post-practice testing performed during regular conditioning compared to pre-competition post-testing practice. Although training regimens for the two days were similar, the higher intensity workout performed in regular conditioning likely increased the competitors' hydration requirements resulting in a diluted concentration of the blood components analysed. Conversely, competitors would moderate conditioning intensity in the pre-competition training. The higher density of blood components analysed in the samples drawn pre-competition supports this, as seen with regards to the variation of Alb levels.

Competitors focused on weight loss and reduced exercise intensity prior to their tournament.

The conditioning methods' effectiveness is unknown, but the decrease in workout intensity is evident considering the conditioning regimen was the same in regular and pre-competition training. It is likely that water intake during regular season training was not sufficient to compensate for electrolyte loss and properly reduce the blood components' concentration. We recommend finding methods for replenishing depleted blood components and not simply maintaining conditioning by just drinking water [6]. Furthermore, biochemical data should be used when coaches design competitors' regular and pre-competition conditioning regimens.

Consideration from reaction time

Neural and systemic response time in simple response became slower post-practice in regular-season conditioning. It is possible that the higher conditioning intensity slowed the competitors' response times. Pre-competition conditioning neural response times, both simple and selective response, were comparatively higher post-training. Previous research reports quicker neural response times after lower and mid-intensity exercise when compared to higher intensity exercise [7, 8]. Response times recorded after regular season conditioning workouts were slower than those observed in pre-competition workouts. This is likely the result of higher intensity strength-building workouts and more rigorous drills that the competitors did during the regular season when compared to the moderate strength-building and drills performed during the pre-competition period. In this research, we identified differences in competitors' routines based on whether they were training in the regular season or preparing for competitions. These observations might be useful for judo coaches tasked with preparing competitors for competitions.

Furthermore, the muscle contraction times

recorded in the pre-competition period were quicker than those observed during regular conditioning. Previous studies have documented a correlation between body weight and contraction speed. The findings of the current research support this. This study confirmed that response time closely correlates with fat mass and body fat percentage. The fat reduction that accompanies weight loss may improve muscular contraction time, resulting in improved performance during competitions.

It is generally accepted that a competitive index or competitive skill level in judo is closely correlated with competitors' weight and physical energy. The current research suggests that moderate weight control and fat reduction have a relatively higher impact on physical strength as seen through changes in neural response times.

Overall consideration

This research's findings suggest that pre-competition conditioning would be optimised if response times were considered as a measure of readiness to compete. In addition, the rapid weight loss accompanying changing body composition may contribute to better response times.

Coaches are strongly encouraged to incorporate biochemical data, neural response times, exercise intensity and water intake regulation into both regular and pre-competition conditioning. Judo competitors participated in this study using common training methods in both regular and pre-competition workout routines [9]. This study confirmed that training intensity during attempts to lose weight resulted in faster neural and muscular response times.

Participants likely focused on technical and tactical training drills during pre-competition training. It is advisable that coaches introduce mental-skills training during the period just prior to tournaments when competitors are heavily focused on weight loss. For example, having competitors practice gripping and other tactical manoeuvres while maintaining just enough physical exertion to facilitate weight-loss [10]. This could be done by pairing some competitors with those in lighter-weight categories prior to competitions to lower workout intensity [11]. Reliable biochemical data collection equipment and methods for judo coaches are essential to support future research in this field.

CONCLUSIONS

Lower weight, fluid body volume, muscle mass, and lean mass were recorded prior to and following practices in the period preceding competitions. Comparisons of data representing water and caloric intake during practice and regular training and pre-competition training periods showed no difference. The concentration of those blood components analysed in samples drawn just preceding competitions was higher than those drawn during regular training. This is likely due to the decrease in exercise intensity prior to competing. Neural response times in simple and selective response actions were quicker in the pre-competition times recorded, while neural response times from simple response tests were slower after regular conditioning workouts. Exercise intensity during practice may affect response times. Muscular contraction times were quicker before and after workouts pre-competition, possibly because of weight loss. Considering the response times recorded in the study, we concluded that the subjects were in better condition during the pre-competition period. In conclusion, the availability of biochemical and response time data is essential for evaluating competitors' fitness.

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