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Gender Differences in the Psychological Response to Weight Reduction in Judoists

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We examined gender-related differences in the psychological response to weight reduction in 43 judoists. Twenty-two males and 8 females who required weight reduction [weight reduction (WR) group] (the average percentages of weight reduction observed for males and females were 3.4% and 4.9%, respectively), and 5 males and 8 females who did not require weight reduction (non-WR group). The POMS scores were measured before and after weight reduction. The TMD (total mood disturbance) score in POMS significantly increased after weight reduction only in WR group males. In the female WR group, the anger and depression scores decreased after weight reduction, and the pre-value of the TMD score in this group was relatively high. The psychological stress may be caused by anxiety engendered by the overall concept of weight reduction before actual weight reduction in females, whereas in males it may be caused by the actual weight reduction.

Key Words: profile of mood states, gender-related difference, psychological response, weight reduction, judo

It is well-recognized that a large number of athletes have periodically to reduce their body weight (BW) to take part in athletic competitions classed by weight. Because judo competitors are classed by weight, i.e., they must compete within a particular weight range, it is more advantageous for a judoist to be as near the upper limits of his or her weight class as possible. Although there have been many studies to evaluate the physiological changes in athletes during the weight reduction period, (14, 18, 21) which have demonstrated some adverse effects, there have been only a few studies regarding psychological changes, the results of which suggested that weight reduction in boxers, judoists, etc. negatively affected their psychological condition (6, 8, 10). Furthermore, to the best of our knowledge, there have been no studies which have examined the differences in psychological changes on a gender-based evaluation during weight reduction for weight-classed sports such as boxing and judo, mainly because only a small number of women participate in such sports.

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For example, women's judo was first officially adopted in the 1992 Olympic Games and thus has a comparatively short history as an international sport.

Several studies have surveyed the gender difference regarding the psychological response to various forms of physical stress (11, 12). Therefore, although we believe that a gender difference to weight reduction also exists in judoists, no studies have, however, examined this. To consider each gender appropriately during weight reduction, it is important to study whether any gender-related difference exists in the psychological response during weight reduction.

To study the gender-related differences in the psychological response to weight reduction, we examined the changes in anthropometric parameters, nutritional intake, and the profile of mood states (POMS) scores (15) in college male and female judoists during the weight reduction period prior to a competition.

Methods

Subjects and Study Protocol

The subjects of the study consisted of 27 male and 16 female college judoists, and were divided into two groups. Thirty subjects (22 male, 8 female) who required weight reduction were defined as the weight reduction (WR) group, and the remaining 13 subjects (5 male, 8 female) who did not need weight reduction were defined as the non-weight reduction (non-WR) group. Average heights and ages were 169.9 ± 4.9 cm, 19.5 ± 0.6 y in the male WR group, 178.3 ± 6.7 cm, 19.0 ± 0.7 y in the male non-WR group, 163.1 ± 5.5 cm, 19.0 ± 1.2 y in the female WR group and 161.4 ± 6.2 cm, 18.9 ± 1.0 y in the female non-WR group, respectively. The male subjects participated in the All Japan Men's Physical Education and University Championship in March 1999, and the female subjects participated in the Tokyo Women's Weight Categorized Championship in May 2000. The WR group and non-WR group members in both genders broken down by weight class are shown in Table 1. Furthermore, there was no difference in motivation regarding winning medals between the WR and non-WR groups. Both athlete and coach decided the weight class after discussion.

Table 1 Number of Subjects of WR Group and Non-WR Group by Weight Class

Male			Female		
Weight class	WR group	Non-WR group	Weight class	WR group	Non-WR group
under-60 kg class	3	0	under-48 kg class	2	1
under-66 kg class	4	0	under-52 kg class	1	0
under-73 kg class	6	2	under-57 kg class	1	1
under-81 kg class	4	1	under-63 kg class	1	2
under-90 kg class	3	1	under-70 kg class	2	3
under-100 kg class	2	1	under-78 kg class	1	1
Total	22	5	Total	8	8

WR group, weight reduction group; non-WR group, non weight reduction group

During the study period, all subjects performed their usual physical training, which consisted of 1 h running and weight training plus 2.5 h judo practice each day; this schedule is shown in Table 2. All subjects had undertaken a weight reduction program before matches for at least 3 y prior to this study. Furthermore, they undertook the weight reduction program under the guidance of their coaches, a program which consisted of energy restriction, water restriction, and sweating in addition to exercise, though there were individual differences.

Table 2 Training Program Per Week During the Research Period

	6:30-7:30 a.m.	9:00-11:30 a.m.	5:30-8:00 p.m.
Monday	Training A	Rest	Training D
Tuesday	Training B	Rest	Training D
Wednesday	Training C	Rest	Training D
Thursday	Training A	Rest	Training D
Friday	Training B	Rest	Training D
Saturday	Training C	Training D	Rest
Sunday	Rest	Rest	Rest

Training A: Interval training consisting of running sprints (800 m × 1, 400 m × 3, 200 m × 3, 100 m × 4) and jogging.
Training B: Weight training.
Training C: Distance running for 30 min and short sprint running (repeated 30-50 m sprint running)
Training D: Judo training for practice.
Rest: Resting period or attend lectures.

We surveyed the changes in the following parameters; anthropometric, nutritional intake, and POMS scores at 20 d (pre-values) and 1 d before the competition (after the weight reduction).

This study was submitted to and approved by the Ethics Committee of the Hirosaki University School of Medicine. The subjects were informed about the study, and, after reading the information letter, they signed a formal written consent.

Anthropometry

The anthropometric variables recorded were body weight (BW), fat free mass (FFM), relative fat mass (percent fat) and fat mass (FM). BW in both genders was measured using a digital electronic scale accurate to the nearest 0.01 kg (model AD6205, A&D Co. Ltd., Japan), with subjects wearing the same attire (swimming costume weighing 150 g).

In males, body density was determined using underwater weighing. Body mass underwater was measured using a load cell (model AD1205-k100, A & D Co. Ltd., Japan) and a weighing indicator (model AD4323B, A & D Co. Ltd., Japan) to the nearest 0.01 kg. Residual lung volume was measured using a closed circuit oxygen rebreathing system, with the nitrogen dilution method (25). The percent fat and FFM were calculated from body density using the Brozek equation (3).

The body composition in females was measured with B-mode ultrasound equipment, as it is impossible to use underwater weighing for females over a research period of approximately 1 month because of menstruation. Subcutaneous fat thickness was measured with B-mode ultrasound equipment (Echo Camera SSD-500, Aloka Co. Ltd., Tokyo) using 3.5 MHz or 7.5 MHz at nine sites on the right side: the biceps and triceps (on the anterior and posterior surface 60% distal between the lateral epicondyle of the humerus and the acromial process of the scapula); the abdomen (at an area 2 to 3 cm to the right of the umbilicus); the subscapular region (at an area 5 cm directly below the angulus inferior of the scapula); and the quadriceps and hamstrings (on the anterior and posterior surface at the midpoint between the lateral condyle of the femur and the greater trochanter). Body density was calculated by the total subcutaneous fat thickness of these six points from the equation of Abe et al.(1) and percent FFM and FM were calculated from measured body density using Brozek's equation (3). All measurements were taken by the same trained individual and all sites were measured three times.

Dietary Survey

A staff dietarian demonstrated the survey methods and procedures to all the subjects. Subjects weighed and recorded the cooked dishes and the ingredients for each dish, the amount consumed, and any left uneaten. Meals/foods and their weights were measured using a digital electronic scale accurate to the nearest 1 g (model M395FL-2U, Shiro Co. Ltd., Osaka, Japan), and were recorded in a dietary survey table by each subject at 20 d (pre-values) and 1 d before the competition, and food intake weight per day was calculated. The intakes of energy, fat, protein, and carbohydrates were estimated using the Food Composition Table (20). Eating snacks between main meals was restricted in all subjects.

Psychological Parameters

The psychological changes during the weight reduction period were evaluated by the profile of mood states (POMS) scores (15), which were used to assess the psychological condition in Tension, Anger, Confusion, Vigor, Depression and Fatigue, and which have been used in many studies to evaluate the effects of exercise and overtraining on the psychological condition of athletes (2, 9). TMD score was calculated to evaluate the state of mental fatigue on the whole from the above-mentioned scores using the following formula:

$$TMD = (Tension + Depression + Anger + Fatigue + Confusion + 100 - Vigor) \quad (16)$$

The POMS evaluation was performed for all subjects at 20 d and 1 d before the competition through paper and pencil surveys administered in the early morning by the same trained tester before BW measurement and exercise.

Statistics

All results are expressed as the mean ± standard deviation. The difference in each parameter before and after the weight reduction, and the difference in each parameter between the WR and non-WR groups, males and females, or pre- and post-values

were tested by a three-way ANOVA. The correlation between the changes in anthropometric parameters during the weight reduction period (post value – pre-value) and the changes in the POMS score during the weight reduction (post value – pre-value) were evaluated with Spearman's correlation coefficient. Two-sided *P*-values of less than 0.05 were regarded as statistically significant.

Results

Table 3 shows the changes in the anthropometric parameters during the weight reduction period. BW, percent fat, FM, and FFM significantly decreased in the WR group males and females after the weight reduction compared to the pre-values (percent fat in male; $P < 0.05$, in female; $P < 0.01$, others in both genders; $P < 0.01$), whereas no significant change was seen in any parameter during the research period in the non-WR group males and females. No differences were seen in the percentage of decreased BW and the decrease in weight during the weight reduction period (pre-value-post-value)/pre-value) between the WR group males (3.4 ± 2.9%, from 2.3% to 5.6%, and 2.8 ± 2.4 kg, from 0.7 kg to 9.2 kg) and females (4.9 ± 2.7%, from 3.1% to 6.2%, and 3.2 ± 1.6 kg, from 1.8 kg to 6.6 kg). The BW and FFM pre-values were significantly higher in the WR and non-WR group males than

Table 3 Changes of Anthropometric Parameters During the Weight Reduction Period in Male and Female College Judoists

	Male		Female	
	Pre	Post	Pre	Post
Body weight (kg)				
WR group	79.6 ± 13.1	76.8 ± 12.4 **	65.5 ± 12.0††	62.3 ± 12.0 **
Non-WR group	82.9 ± 12.2	83.2 ± 12.1	64.8 ± 8.4 ††	64.5 ± 8.1
%Fat (%)				
WR group	11.3 ± 6.1	10.7 ± 6.3 *	19.2 ± 3.6 ††	18.1 ± 3.2 **
Non-WR group	11.0 ± 5.6	11.4 ± 5.4	20.1 ± 2.8 ††	19.8 ± 2.7
Body fat (kg)				
WR group	9.6 ± 6.7	8.8 ± 6.4 **	12.9 ± 4.6 ††	11.6 ± 4.2 **
Non-WR group	9.5 ± 5.8	9.9 ± 5.8	13.2 ± 3.4 ††	12.9 ± 3.3
FFM (kg)				
WR group	69.9 ± 7.7	67.9 ± 7.3 **	52.6 ± 7.8 ††	50.8 ± 8.1 **
Non-WR group	73.3 ± 7.1	73.2 ± 6.8	51.6 ± 5.1 ††	51.5 ± 5.0

Results are expressed as mean ± standard deviation.
Pre: pre-weight reduction findings. Post: post-weight reduction findings. WR: weight reduction.
In males, Non-WR group: $n = 5$, WR group: $n = 22$. In females, Non-WR group: $n = 8$, WR group: $n = 8$. *: $P < 0.05$, **: $P < 0.01$, significantly different from the pre-value in each gender and group.
††: $P < 0.01$, significantly different from the pre-values between male and female in each group.

in the females. In contrast, the percent fat and BW pre-values were significantly higher in the WR and non-WR group females than in the males.

Table 4 shows the changes of intakes of energy, fat, protein, and carbohydrates per BW during the weight reduction period. Total energy, protein, fat, and carbohydrate intake per BW significantly decreased in the WR group males and females after the weight reduction compared with the pre-values ($P < 0.01$ in each), but no significant change in any parameter was noted in either gender in the non-WR group. The ratios of decreasing total energy, protein, fat, and carbohydrate intake were 43.9 ± 18.4%, 39.6 ± 21.9%, 31.2 ± 23.3%, and 46.0 ± 18.5%, respectively, in the WR group males and 54.7 ± 12.4%, 61.6 ± 13.7%, 56.6 ± 19.4%, and 50.1 ± 15.7%, respectively in the WR group females. The increasing rates in three nutrients were greater in females than in males. On the other hand, in the non-WR group, such parameters were unchanged in this period.

The changes in the POMS scores during the weight reduction period are shown in Table 5 and Figure 1. In the WR group males, the Tension, Fatigue, Vigor and TMD scores significantly increased after the weight reduction compared with the pre-value. In the WR group females, although the Anger, Confusion, Depression, Tension, and TMD scores showed tendencies to decrease after weight reduction compared with the pre-values, the changes were not significant. In the non-WR

Table 4 Changes of Intakes of Energy, Protein, Fat, and Carbohydrate Per Body Weight During the Weight Reduction Period in Male and Female College Judoists

	Male		Female	
	Pre	Post	Pre	Post
Total energy intake (kcal/kg)				
WR group	41.4 ± 10.0	23.4 ± 7.2 **	38.0 ± 8.4	18.1 ± 6.7 **
Non-WR group	36.2 ± 7.9	40.7 ± 14.0	29.5 ± 9.4	25.0 ± 12.1
Protein intake (g/kg)				
WR group	1.4 ± 0.4	0.8 ± 0.2 **	1.2 ± 0.3	0.5 ± 0.2 **
Non-WR group	1.3 ± 0.3	1.3 ± 0.5	1.0 ± 0.4	0.8 ± 0.3
Fat intake (g/kg)				
WR group	0.8 ± 0.3	0.5 ± 0.2 **	1.2 ± 0.3 ††	0.5 ± 0.2 **
Non-WR group	0.7 ± 0.2	1.0 ± 0.4	0.9 ± 0.4	0.8 ± 0.5
Carbohydrate intake (g/kg)				
WR group	7.1 ± 1.8	3.9 ± 1.3 **	5.3 ± 1.4 ††	2.8 ± 1.3 **
Non-WR group	6.3 ± 1.6	6.6 ± 2.2	4.3 ± 1.3	3.5 ± 1.7

Results are expressed as mean ± standard deviation.
Pre: pre-weight reduction findings. Post: post-weight reduction findings. WR: weight reduction.
In males, Non-WR group: $n = 5$, WR group: $n = 22$. In females, Non-WR group: $n = 8$, WR group: $n = 8$. **: $P < 0.01$, significantly different from the pre-value in each gender and group. †: $P < 0.05$, ††: $P < 0.01$, significantly different from the pre-values between male and female in each group.

group male and females, no constant trend was seen in the changes of these parameters during the research period. On the other hand, the pre-values of Confusion, Depression and TMD scores in females were significantly higher than those in males in the WR group, with no significant difference seen in the pre-value scores in these parameters between the male and female non-WR groups. In addition, no relationship was seen between changes in macronutrient intake and the POMS results (data not shown).

Spearman's correlation coefficients between changes in the POMS scores and the changes in the anthropometric parameters during the weight reduction period are shown in Table 6. The changes in the Depression and Fatigue scores were inversely related to the changes of BW during the weight reduction period,

Table 5 Changes of the Scores in POMS During the Weight Reduction Period in Male and Female College Judoists

	Male		Female	
	Pre	Post	Pre	Post
Anger				
WR group	6.2 ± 4.5	6.6 ± 6.8	11.0 ± 7.5	8.0 ± 5.4
Non-WR group	5.2 ± 4.2	9.6 ± 5.6	5.1 ± 5.3	5.8 ± 7.2
Confusion				
WR group	7.3 ± 2.4	8.1 ± 4.7	12.4 ± 7.0†	10.1 ± 8.6
Non-WR group	8.6 ± 5.3	9.8 ± 4.0	7.9 ± 3.3	8.1 ± 3.8
Depression				
WR group	5.6 ± 5.1	8.1 ± 9.7	17.9 ± 17.3†	13.6 ± 11.8
Non-WR group	9.8 ± 7.5	12.4 ± 9.4	7.8 ± 6.1	7.3 ± 10.7
Fatigue				
WR group	5.7 ± 4.1	8.2 ± 6.0 **	8.8 ± 6.8	10.4 ± 10.4
Non-WR group	7.0 ± 3.1	6.6 ± 1.3	8.0 ± 3.8	9.3 ± 8.4
Tension				
WR group	9.5 ± 3.9	10.7 ± 5.7 *	13.8 ± 6.8	10.6 ± 6.6
Non-WR group	13.4 ± 3.4	10.8 ± 3.6	9.8 ± 3.4	9.3 ± 4.4
Vigor				
WR group	9.6 ± 4.7	7.5 ± 4.9 *	12.9 ± 4.2	10.5 ± 8.9
Non-WR group	11.0 ± 1.6	11.2 ± 5.0	11.0 ± 9.5	10.0 ± 9.6
TMD				
WR group	122.6 ± 14.6	134.1 ± 32.3 *	150.8 ± 44.7†	142.2 ± 46.3
Non-WR group	130.8 ± 20.0	131.8 ± 13.3	127.5 ± 25.0	129.6 ± 36.7

Results were expressed as mean ± standard deviation.
Pre: pre-weight reduction findings. Post: post-weight reduction findings. WR: weight reduction.
In males, Non-WR group: $n = 5$, WR group: $n = 22$. In females, Non-WR group: $n = 8$, WR group: $n = 8$. *: $P < 0.05$, **: $P < 0.01$, significantly different from the pre-value in each gender and group.
†: $P < 0.05$, significantly different from the pre-values between male and female in each group.

Table 6 Spearman's Correlation Coefficients Between the Changes in POMS Scores and the Changes of Anthropometric Parameters During the Weight Reduction Period in Male and Female College Judoists

	Male						
	Anger	Confusion	Depression	Fatigue	Tension	Vigor	TMD
Body weight	-0.140	-0.370	-0.455*	-0.420*	-0.347	-0.069	-0.405*
%Fat	-0.241	-0.555**	-0.479*	-0.555**	-0.436*	-0.190	-0.535**
Body fat	-0.163	-0.530**	-0.452*	-0.501**	-0.418*	-0.217	-0.495**
FFM	-0.094	-0.184	-0.362	-0.277	-0.227	-0.046	-0.260
	Female						
	Anger	Confusion	Depression	Fatigue	Tension	Vigor	TMD
Body weight	0.283	0.328	0.334	0.017	0.317	0.182	0.208
%Fat	0.156	0.020	0.134	-0.118	-0.051	0.288	-0.013
Body fat	0.223	0.139	0.269	-0.077	0.086	0.299	0.081
FFM	0.258	0.362	0.302	0.062	0.375	0.086	0.233

POMS: profile of mood state. In male: $n = 27$, In female: $n = 16$.
*: $P < 0.05$, **: $P < 0.01$.

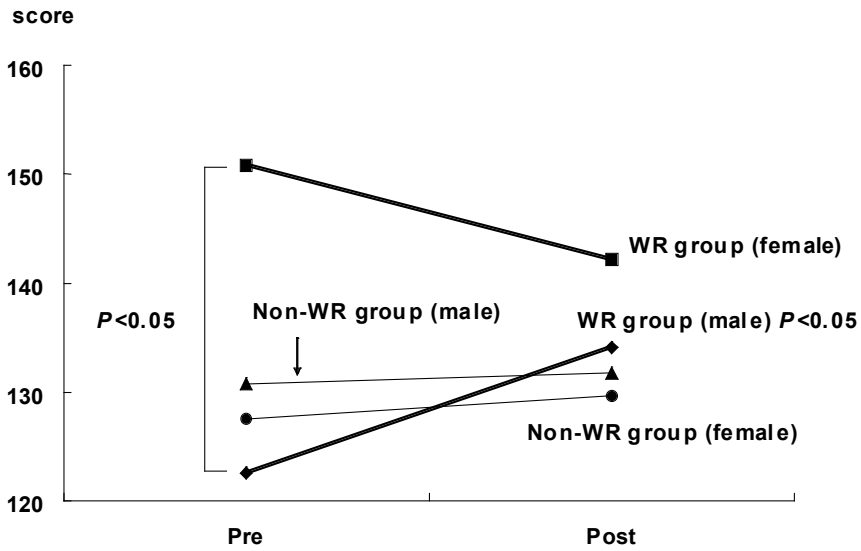

Figure 1—Changes in the TMD scores during the weight reduction period in male and female college judoists. * $P < 0.05$, significant difference in the pre-values between the male and female WR groups, and difference in the values between pre- and post- values in the male WR group.

and the changes in the Confusion, Depression, Fatigue, Tension, and TMD scores were inversely related to the changes in percent fat and FM in male subjects. No significant correlation between changes of these parameters was seen in female subjects.

The results of the tournaments were as follows. In the male WR group, two subjects were champions, and two subjects got second and third place, respectively. In the female WR group, one subject won the championship. However, we found no significant relationship between these results and the weight reduction rates and the changes in POMS scores during the weight reduction period.

Discussion

This study has two limitations. First, the weight reduction was not strictly controlled, as all the subjects performed weight reduction individually through dietary/water restriction and training exercise. Accordingly, it is unclear whether the relationship between the POMS scores and weight reduction depended on dietary/water restriction or training exercise. Second, we evaluated body density for men and women by different methods; the underwater weighing method for men and subcutaneous fat thickness for women. We wanted to use the underwater weighing method as this method is one of the most precise, although one research team has noted its shortcomings (4). However, we cannot use this method for females during a study period due to the effects that the menstrual cycle may have on hydration status and the assumptions for underwater weighing.

In the present study, the average percentages of decreased BW during the weight reduction period for the male and female WR group were 3.4 ± 2.9% and 4.9 ± 2.7%, respectively. Fogelholm et al. suggested that a decrease of over 5% in BW over 3 wk caused a deterioration of physical performance in judoists and wrestlers (7), further, Rankin et al. have shown that a 3 to 4% reduction in body weight reduces high-intensity intermittent arm power performance (19). Therefore, the values of BW decrease in the current study were on the borderline of the safety range for health/performance maintenance during the weight reduction period. Moreover, our results also showed a significant decrease in FFM during the weight reduction period in the WR group males and females, suggesting a possible reduction in actual muscle tissue which could directly bring about a deterioration of the subjects' performance during the competition (14, 18, 21). This may be due to intensive weight reduction. On the other hand, our results demonstrated that the pre-values of BW and FFM were significantly higher in males than in females and the pre-values of percent fat and FM were significantly higher in females than in males. Males and females have specific gender-related characteristics with respect to body composition (5, 22), and our results agree with previous studies. In other words, the effects of weight reduction may be more easily seen in females, and the target weight may be more easily achieved than in males, perhaps due to the gender anthropometric differences of FM and given that percent fat tends to be higher in females than in males, while the opposite is true for FFM and BW.

In the present study, intakes of energy, carbohydrates, protein, and fat significantly decreased after weight reduction in the WR group males and females. The ratio of decreasing intakes of energy and nutrients in the WR group was similar for both genders.

In the current results, the TMD and the Fatigue, Tension, and Vigor POMS scores significantly increased after the weight reduction in the WR group males. Furthermore, the change in the TMD scores significantly correlated with the BW changes during the weight reduction period in males. These findings suggested that the actual process of weight reduction per se increased psychological stress in males, and the greater the weight reduction achieved, the more influence was seen on psychological stress. On the other hand, the WR group female TMD and other scores pointed to a positive mood profile trend after the weight reduction, although this change was not significant. These findings suggested that female subjects had a good psychological reaction to weight reduction. Our finding suggests that psychological stress may be caused by the actual weight reduction in males, whereas in females it may be caused by anxiety engendered by the overall concept of weight reduction before actually beginning the physical process. This concept was supported by the finding that the pre-values of the TMD score in the female WR group were relatively high, because these values were higher than the pre-values in the male WR group ($P < 0.05$) and in the female non-WR group, though the difference was not significant. The reason why such stress (high POMS scores) in the female WR group decreased after weight reduction may be due first to the fact that anxiety engendered by the ideation of weight reduction decreased with successful progress during the weight reduction period; or second, the subjects gained increased satisfaction through awareness of a possible aesthetic improvement to their figure due to the weight reduction, i.e., slimming down, possibly due to a sense of "self improvement" following successful weight loss. Several studies have surveyed the gender difference regarding the psychological response to various forms of physical stress (11, 12, 23, 24). O'Connor's investigation (17) pointed to a clear gender-related difference between females and males under physical stress, with females adjusting better psychologically than the males. These findings were also commented on by Karibe et al. (11).

Hypothalamic-pituitary-adrenal axis stress responses may be one mechanism underlying sex differences in depression or stress events (13, 23, 24). For example, Stroud et al. reported that men showed significantly greater cortisol responses to the achievement challenges, but women showed greater cortisol responses to the social rejection challenges (23). Stroud's result in general agrees with the results of the current study; the achievement challenges means accrual of weight reduction, and the social rejection represents the anxiety generated by beginning the weight reduction.

The lesson to be learned from the current study is that psychological support should be provided specifically at the beginning of the weight reduction regimen for female judoists who are required to undergo weight reduction before competitions.

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