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*Original Article*

# The Effect of the Weight Reduction on the Salivary Cortisol Levels of Judo Players

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## Abstract

**The purpose of this study was to investigate the effect of weight reduction prior to a competition on the salivary cortisol level for first-rate judo players. Subjects were divided into three groups by the weight reduction rate. On the day before the competition, the cortisol levels of the low- and high-weight reduction group showed a tendency to decrease and were significantly lower than that of the non-weight reduction group ($p<0.05$). However, with regard to the change in the stress indices, there was a difference between the high- and low-weight reduction groups. In the high-weight reduction group alone, there was a significant increase in the stress indices on the day before the competition ($p<0.05$). These findings suggest that the HPA axis is affected during the relatively early stage of weight reduction and mental stress is increased at the higher weight reduction rate.**

**Key words**: cortisol, saliva, weight reduction, mental stress, judo players

## Introduction

Stress management before a competition for athletes is very important, especially for those who reduce their weight such as boxers or judo players. In general, the adrenocortical hormone is well known as a stress marker, and cortisol is representative of it. The stressor increases its blood or salivary level through the hypothalamus-pituitary-adrenal (HPA) axis[1)]. The temporary increase in the cortisol level may be considered as a normal phenomenon during heavy exercise training[2–4)]. However, with regard to the effect of weight reduction on the cortisol level, previous studies have been carried out mainly for obese non-athletes treated with a weight reduction program, and the findings are contradictory[5,6)].

Meanwhile, the use of a saliva sample as a component of the human body is very effective because of convenience and not requiring an injection[7)]. Recently, good determination methods of the salivary cortisol levels have been established[8)]. In addition, some previous studies have found a high correlation between the salivary and serum cortisol levels[8–10)]. Thus, in the present study, we investigated the effect of weight reduction prior to a competition on the salivary cortisol levels for first-rate judo players.

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## Materials and Methods

*Subjects and protocol*

Subjects were 15 male judo players (mean age±SD; 19.5±0.9 years) who belonged to the Nippon Sport Science University Judo Club. All individuals were non-smokers. Seven of them reduced their weight prior to a competition. The competition was very important for them, because it was for choosing some representative players of the club.

The collection of the measurements was carried out on three different days: 20 days before the competition (before weight reduction), the day before the competition (the peak of weight reduction) and 7 days after the competition. On each collection day, the physical characteristics (height, body weight, fat percentage) and the mental health status (GHQ-28[11)], Zung-SDS[12,13)]) were measured, and the saliva samples were collected.

The saliva samples were collected at 09:00 using Salivette® (Sarstedt Co. Ltd., Nümbrecht), a device to obtain saliva by centrifuging (at 3,000 rpm for 15 min) from cotton that subjects have bitten (for 2 min). At 7 days after the competition, however, they were collected between 08:00–08:30 due to unavoidable circumstances. The saliva was stored at –50°C until the assay.

The salivary cortisol levels were determined by ELISA as described previously[10)].

*Statistical analysis*

All values were expressed as the mean±SD. The measurements on the day before the competition and 7 days after the

competition were compared with that of 20 days before the competition using Student's paired *t* test. In addition, the one-way analysis of variance was used for the comparison between groups. Values were considered to be significantly different if $p<0.05$.

## Results

*Grouping of subjects*

Subjects were divided into three groups by the weight reduction rate (WRR, %) as described by Kurakake et al.[14]: the non-weight reduction group (WRR<3%), the low-weight reduction group (3≤WRR<6%) and the high-weight reduction group (WRR≥6%). WRR was obtained using the following equation[14]:

$$WRR=[(a-b)/a]\times 100$$

Here, a is the body weight at 20 days before the competition, and b is that on the day before the competition.

At 20 days before the competition, there was no significant difference in the physical characteristics, mental health status or the salivary cortisol levels between the three groups (Table 1).

*Effect of weight reduction* (Table 2 and Fig. 1)

There was no significant change in the salivary cortisol levels during the weight reduction. On the day before the competition, however, those of the low- and high-weight reduction group showed a tendency to decrease and were significantly lower than that of the non-weight reduction group ($p<0.05$). In addition, their recovery was observed at 7 days after the competition.

With regard to the stress indices of the high-weight reduction group, there was a significant increase on the day before the competition ($p<0.05$). However, those of the non- and low-weight reduction groups showed similar changes. On the day before the competition, there was the not significant but marked correlation between WRR and each of the stress indices (Fig. 2).

There was no significant correlation between the salivary cortisol levels and each of the stress indices during the weight reduction.

**Table 1 Characteristics of subjects on 20 days before the competition (before weight reduction)**

| | Non-weight reduction group (n=8) | Low-weight reduction group (n=3) | High-weight reduction group (n=4) |
|---|---|---|---|
| Cortisol (μg/dl) | 0.45±0.23 | 0.31±0.04 | 0.21±0.09 |
| GHQ-28 | 4.5±2.6 | 6.3±2.1 | 5.8±4.4 |
| Zung-SDS | 39.3±4.3 | 40.0±2.0 | 42.0±10.1 |
| Height (cm) | 173.6±5.9 | 170.3±6.8 | 168.8±5.2 |
| Body weight (kg) | 81.8±14.9 | 78.2±12.8 | 85.1±15.9 |
| BMI (kg/m$^2$) | 27.0±4.4 | 26.9±3.8 | 29.7±4.0 |
| Fat percentage (%) | 12.1±4.0 | 10.8±7.4 | 17.9±6.2 |

Values are expressed as the mean±SD.

**Table 2 Change in each parameter during the weight reduction**

| | 20 days before the competition | The day before the competition | 7 days after the competition |
|---|---|---|---|
| Non-weight reduction group (n=8) | | | |
| Cortisol (μg/dl) | 0.45±0.23 | 0.43±0.20 | 0.60±0.14 |
| GHQ-28 | 4.5±2.6 | 4.9±2.5 | 3.3±2.0 |
| Zung-SDS | 39.3±4.3 | 40.5±5.1 | 39.8±6.1 |
| Body weight (kg) | 81.8±14.9 | 81.1±14.9 | 82.0±15.3 |
| BMI (kg/m$^2$) | 27.0±4.4 | 26.8±4.4 | 27.1±4.5 |
| Fat percentage (%) | 12.1±4.0 | 12.3±4.9 | 10.8±4.9* |
| Low-weight reduction group (n=3) | | | |
| Cortisol (μg/dl) | 0.31±0.04 | 0.13±0.07 | 0.33±0.20 |
| GHQ-28 | 6.3±2.1 | 6.3±0.6 | 4.3±2.5 |
| Zung-SDS | 40.0±2.0 | 41.3±1.2 | 40.7±5.0 |
| Body weight (kg) | 78.2±12.8 | 74.9±12.4* | 77.6±12.7 |
| BMI (kg/m$^2$) | 26.9±3.8 | 25.8±3.6* | 26.7±3.7 |
| Fat percentage (%) | 10.8±7.4 | 10.0±6.3 | 10.4±7.4 |
| High-weight reduction group (n=4) | | | |
| Cortisol (μg/dl) | 0.21±0.09 | 0.14±0.11 | 0.49±0.21 |
| GHQ-28 | 5.8±4.4 | 9.3±6.4* | 5.5±4.0 |
| Zung-SDS | 42.0±10.1 | 47.8±10.9* | 42.5±7.6 |
| Body weight (kg) | 85.1±15.9 | 78.4±14.9** | 83.8±13.9 |
| BMI (kg/m$^2$) | 29.7±4.0 | 27.3±3.8** | 29.3±3.4 |
| Fat percentage (%) | 17.9±6.2 | 16.7±7.1 | 18.6±7.8 |

Values are expressed as the mean±SD.
Significantly different from 20 days before the competition, *$p<0.05$, **$p<0.01$ (Student's paired *t* test).

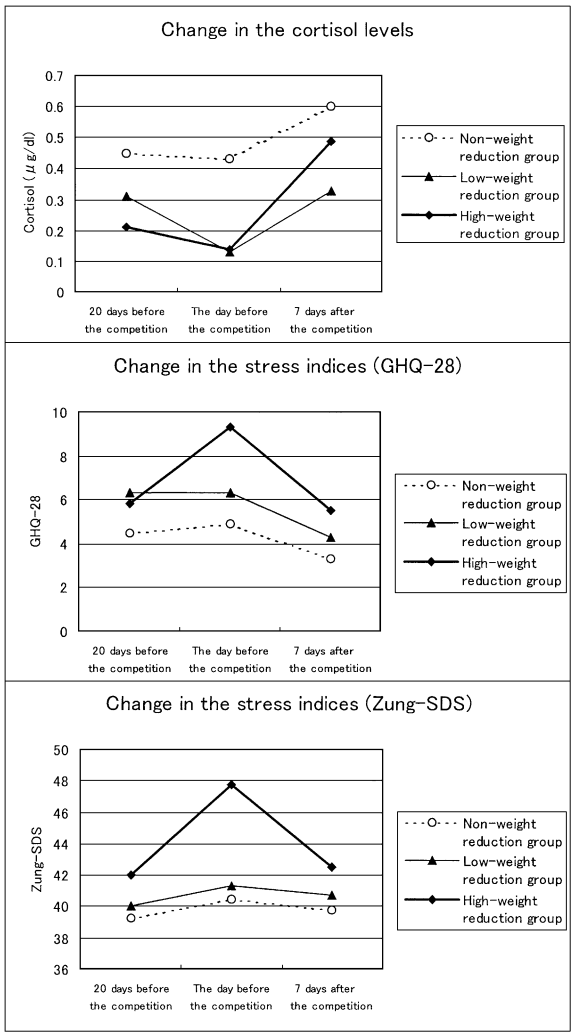


**Fig. 1 Change in the cortisol levels and the stress indices during the weight reduction.**

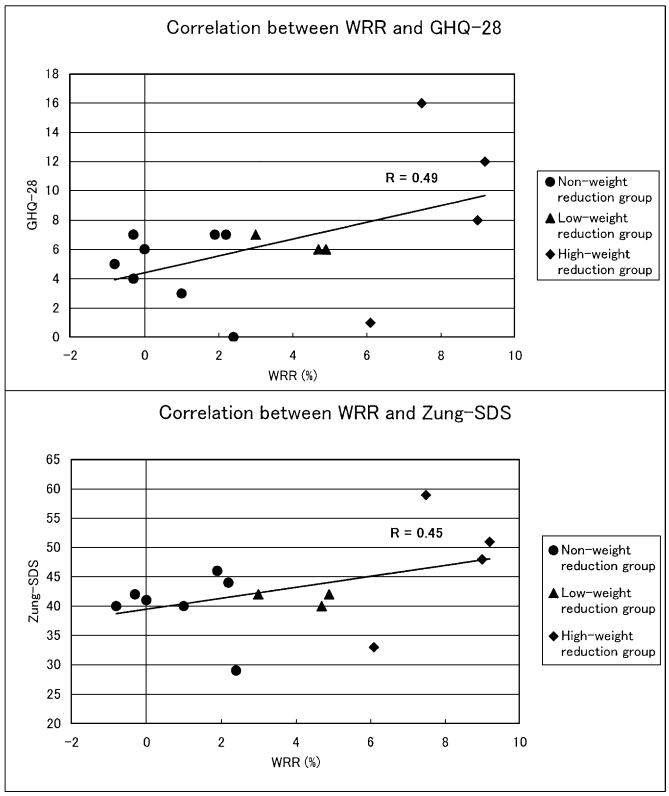


**Fig. 2 Correlation between WRR and the stress indices on the day before the competition.**

## Discussion

The cortisol levels at 20 days before the competition was high to some extent. It may have resulted from the early sampling hour (09:00). In general, both serum and salivary cortisol levels show a spiking in the early morning and then decrease gradually throughout the day[1,9,10,15]. It is suggested by the findings that the cortisol levels were higher at 7 days after the competition in which the sampling hour was earlier (08:00–08:30). Meanwhile, the BMI of the present subjects was generally high. However, Yanovski et al.[5] and Scavo et al.[6] reported that the serum cortisol levels are not significantly different between obese subjects and normal weight subjects.

On the day before the competition, the cortisol levels of the low- and high-weight reduction groups showed a tendency to decrease and were significantly lower than that of the non-weight reduction group ($p<0.05$). A decrease in the cortisol level during weight reduction has been reported[6]. However, it should be noted that the low- and high-weight reduction groups showed similar changes. This suggests that the HPA axis is affected even at the relatively low weight reduction rate. In addition, the cortisol level did not change during the short-term fasting (8–10 h)[16], which suggests that the change in the cortisol levels observed in the present study results not from the fasting itself but from the weight reduction.

However, the cortisol level of the non-weight reduction group hardly changed on the day before the competition. The increase in the cortisol level due to mental stress before a competition was observed by Booth et al.[17]. However, their study was carried out on the day of the competition. In addition, the present subjects were first-rate judo players, even though they were students. Therefore, they should have known well the way of relieving such mental stress.

With regard to the change in the stress indices, there was a difference between the high- and low-weight reduction group. Although, in the high-weight reduction group, there was a significant increase in the stress indices on the day before the competition ($p<0.05$), it was not observed in the low-weight reduction group. In addition, the stress indices of the low-weight reduction group showed a change similar to that of the non-weight reduction group.

These findings suggest that the HPA axis is affected in the relatively early stage of the weight reduction and the mental stress increases at the higher weight reduction rate. A high cortisol level may create favorable conditions for viral infection or athletic injury due to its immunosuppressive and muscle catabolic effects[1,18–20]. Therefore, appropriate weight reduction that is not accompanied by mental stress may be useful for athletes.

Finally, there was no significant correlation between the cortisol levels and each of the stress indices throughout this study. According to previous studies, the baseline cortisol levels are not always related to the stress levels at that point[20,21]. These findings may mainly result from the individual variation of the baseline cortisol levels. However, the present subjects formed a special group, and the number of them was very small. Thus, further

studies should be carried out using more various and larger groups.

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