

# Correlation between Heart Rate on Morning Rising and Condition of Judo Players during Training Camp

## Authors' Contribution:

- A** Study Design
- B** Data Collection
- C** Statistical Analysis
- D** Manuscript Preparation
- E** Funds Collection

**Akitoshi Sogabe**<sup>1A@C@D@E</sup>, **Taketo Sasaki**<sup>2A</sup>, **Mitsuharu Kaya**<sup>3@</sup>, **Kosuke Nagaki**<sup>4@</sup>, **Shunsuke Yamasaki**<sup>1@</sup>

<sup>1</sup> Education and Research Center for Sport and Health Science, Konan University, Kobe, Japan

<sup>2</sup> Faculty of Human Development and Culture Department of Physical Education, Fukushima University, Fukushima, Japan

<sup>3</sup> Liberal Arts Center, Hyogo University of Health Sciences, Kobe, Japan

<sup>4</sup> Faculty of School Education, Hyogo University Teacher Education, Kato, Japan

**Source of support:** Departmental sources

**Received:** 21 April 2009; **Accepted:** 13 May 2009; **Published online:** 4 June 2009

## Abstract

### Background and Study Aim:

We attempted to determine whether measurement of heart rate on rising can be used as a simple method for assessing physical and mental conditioning.

### Material/Methods:

The subjects for this study were 11 male Japanese college Judo players (age:  $20.5 \pm 1.4$  years) who visited the United States to compete. The investigation period was 8 days. Each subject was asked to record heart rate and sleep length, evaluate his physical and mental conditions, and complete a POMS questionnaire every morning on rising. The days with the highest and lowest heart rates were extracted from the recorded data for each subject, and the sleep length, physical and mental conditions, and POMS scores on those days were compared.

### Results:

Correlation coefficients between heart rate and each of the factors exhibiting significant differences were calculated. Negative correlations were found for sleep length ( $r = -0.678$ ,  $p < 0.001$ ), physical condition ( $r = -0.657$ ,  $p < 0.001$ ) and mental condition ( $r = -0.577$ ,  $p = 0.004$ ) while positive correlations were found for POMS scales of Fatigue ( $r = 0.468$ ,  $p = 0.026$ ) and Confusion ( $r = 0.506$ ,  $p = 0.015$ ).

### Conclusions:

Although psychological condition tends to be considered less serious than physical condition, poor psychological conditioning can cause such problems as lack of sleep, which can lead to an imbalance of the autonomic nervous system and eventually to impairment of physical condition. It may also be possible to develop players' interest in and habit of managing their condition on their own by promoting them to undertake such activities as measuring their heart rate.

### Key words:

POMS • overtraining • physical condition • mental condition

### Author's address:

Akitoshi Sogabe, Education and Research Center for Sport and Health Science, Konan University; 9-4 Naka Koyochi Higashinadaku Kobe, Japan 658-0032; e-mail [sogabe@konan-u.ac.jp](mailto:sogabe@konan-u.ac.jp)

## BACKGROUND

**Overtraining** – training at a work level beyond physical tolerance limits so that the body is unable to recover completely during rest periods. It commonly causes physical and mental fatigue resulting in a decrease in the quality of performance.

A number of Judo competitions are held throughout the year. Unlike in the cases of baseball and American football, there is no distinct line between on and off seasons for Judo players. This makes it difficult to introduce a clear concept of periodization into the world of Judo. In addition, a number of camp training sessions are held during the long vacation times in high school and col-

lege, such as in the summer break, and it can thus be problematic for players to manage their physical condition; continuously performing training without a well-established plan under such circumstances may result in short-term overreaching or even **overtraining**. There is no definite line between training hard and overtraining, and this also depends on the physiological tolerance of an individual to training. A training plan suited to one individual may result in overtraining in another. Therefore,

management of each player's physical condition is important for successful training planning and camp training. According to Fry et al. [1], who classified previously reported symptoms of overtraining from the physiological, psychological and immunological aspects, the symptoms of overtraining include delay in recovery from fatigue, change in blood pressure, change in resting heart rate, increase in respiratory rate, experience of depression, and lack of motivation. Players who have not developed overreaching or overtraining may experience overworking, showing an increase in heart rate on morning rising and complaining of apparent fatigue without a decrease in performance [2]. A study monitoring changes in heart rate on rising in marathon runners over a 20-day period showed an increase in heart rate between days 8 and 20 with no change in daily average running speed [3]. For sport events such as running, in which athletes' records are measurable, it is possible to ascertain the status of performance to some extent based on the athletes' records. However, for one-on-one sports such as Judo, quantitative assessment of performance is impossible. Thus, assessment of both physiological and mental changes is important for each individual Judo player.

**POMS** – a psychological test designed to measure a person's affective state. There include tension, depression, anger, vigor, fatigue, and confusion.

**The Profile of Mood States (POMS)** has been used to assess mental condition. A study investing changes in POMS during camp training showed that the parameter "Depression/Dejection" increased while "Vigor" decreased on an intermediate day [4]. Another study comparing POMS pre and post camp training showed an increase in "Fatigue" and decrease in "Vigor" post camp training[5]. These studies suggest that the psychological condition of athletes readily changes during a training camp. In addition, when attending an international competition, players need to maintain a good mental condition as well as a good physical condition. It is therefore necessary to examine the effect of their physical condition on their mental status. This assessment should preferably be performed as simply and objectively as possible.

To this end, here we measured the heart rate of judo players on morning rising to assess their physical condition and asked them to complete a conditioning assessment sheet and POMS questionnaire to assess their psychological condition, thereby assessing their overall condition during an overseas training camp. On the basis of the results, we attempted to determine whether measurement of heart rate on rising can be used as a simple method for assessing physical and mental conditioning.

## MATERIAL AND METHODS

The subjects for this study were 11 male Japanese college Judo players (age:  $20.5 \pm 1.4$  years) who visited the

United States to compete with American college all-stars. The investigation period was 8 days from the second day after arrival in the U.S. to the morning of the day before the return date. Each subject was asked to record heart rate and sleep length, evaluate his physical and mental conditions, and complete a POMS questionnaire every morning on rising. Heart rate on rising was measured from the radial artery over 30 seconds in a lateral recumbent position on waking, and the value was doubled to convert to a heart rate per 60 seconds before the value was recorded. Sleep length was calculated and recorded based not on predetermined bed-time and wake-up time but on the actual duration of sleep. Physical and mental conditions were subjectively evaluated into five grades: good (5), somewhat good (4), usual (3), somewhat poor (2), and poor (1). Scores for six POMS scales extracted by factor analysis (Tension/Anxiety (T-A), Depression/Dejection (D), Anger/Hostility (A-H), Vigor (V), Fatigue (F), and Confusion (C)) were calculated. The days with the highest and lowest heart rates were extracted from the recorded data for each subject, and the sleep length, physical and mental conditions, and POMS scores on those days were compared. The paired t-test was used to assess whether there were differences in each factor between the days with the highest and lowest heart rates. Correlations between each factor were also tested. Fisher's  $r$  to  $z$  transformation was used to test correlation coefficients. Statistical significance was determined at a significance level of 5%.

## RESULTS

Changes in each factor on the days with the highest and lowest heart rates are summarized in Table 1. The lowest and highest values of heart rate on rising during the investigation period were  $61.1 \pm 6.7$  and  $77.9 \pm 6.4$  beats/min, respectively, with a significant increase of 16.8 beats/min in heart rate on rising between the highest and lowest values ( $p < 0.001$ ). Sleep length decreased by 2.0 hours from  $6.0 \pm 1.3$  hours on the day with the lowest heart rate to  $4.0 \pm 2.1$  hours on the day with the highest heart rate ( $P = 0.002$ ). Physical condition also decreased by 1.9 points between the days with the lowest and highest heart rates ( $p < 0.001$ ). Similarly, mental condition decreased by 1.7 points between the days with the lowest and highest heart rates ( $p < 0.001$ ). Changes in scores for each POMS scale are summarized in Table 2 and represented in graph form in Figure 1. F score referring to fatigue status increased by 7.2 points ( $p = 0.014$ ) and C score increased by 3.3 points ( $p = 0.036$ ) between the days with the lowest and highest heart rates. No significant differences were observed for any other scales.

Correlation coefficients between heart rate and each of the factors exhibiting significant differences were calcu-

**Table 1.** Changes in each factor on the days with the highest and lowest heart rates.

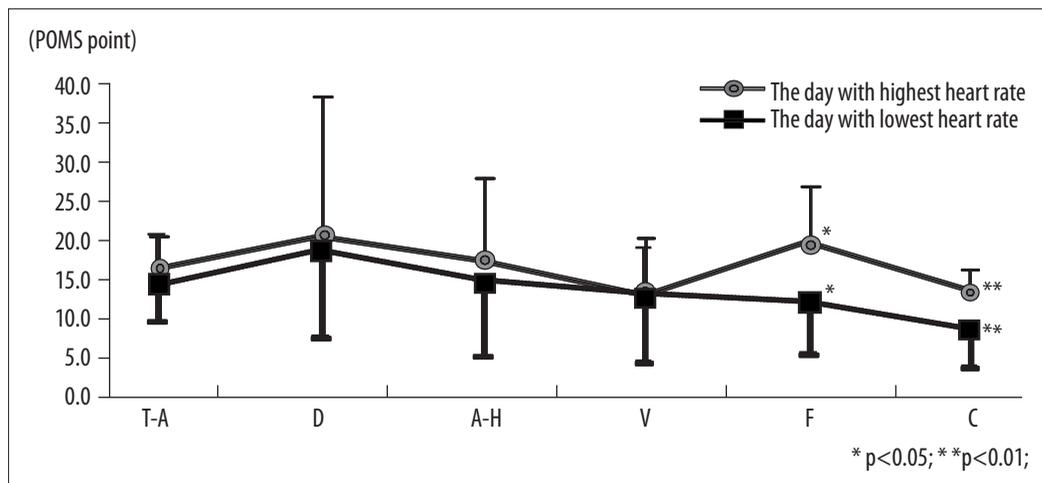
	The day with lowest heart rate		The day with highest heart rate
Heart rate (beats/min)	61.1±6.7	**	77.9±6.4
Sleep length (hours)	6.0±1.3	**	4.0±2.1
Physical condition	3.5±0.7	**	1.6±1.2
Mental condition	4.0±0.8	**	2.3±1.4

\*\* p&lt;0.01.

**Table 2.** Changes in scores for each POMS scale.

	The day with lowest heart rate		The day with highest heart rate
T-A	12.8±4.3		14.7±4.5
D	17.0±10.1		18.7±10.6
A-H	13.3±10.0		15.7±9.4
V	11.9±5.9		11.4±8.6
F	10.8±6.7	*	18.0±6.
C	8.1±2.7	**	11.4±5.0

\* p&lt;0.05; \*\* p&lt;0.01.

**Figure 1.** Changes in scores for each POMS scale on the days with the highest and lowest heart rates. F score referring to fatigue status increased by 7.2 points ( $p=0.014$ ) and C score increased by 3.3 points ( $p=0.036$ ) between the days with the lowest and highest heart rates.

lated. Negative correlations were found for sleep length ( $r=-0.678$ ,  $p<0.001$ ), physical condition ( $r=-0.657$ ,  $p<0.001$ ) and mental condition ( $r=-0.577$ ,  $p=0.004$ ) while positive correlations were found for POMS scales of Fatigue ( $r=0.468$ ,  $p=0.026$ ) and Confusion ( $r=0.506$ ,  $p=0.015$ ).

## DISCUSSION

Measuring daily changes in cardiovascular factors is considered to provide measures for the assessment of overtraining. When physical condition is favorably adapted to a training program, heart rate decreases both at rest and following exercise load [6]. Conversely, under

an overworking condition, heart rate is said to increase at rest, during exercise as well as during recovery [2]. The present investigation, although conducted during a temporary training camp and symptoms should be distinguished from overtraining syndrome, revealed that similar symptoms can be observed even in a short-term conditioning investigation. Comparison of other condition-related factors between the days with the lowest and highest heart rates on morning rising revealed a longer sleep length and better physical and mental conditions on the day with the lowest value of heart rate on rising than on the day with the highest value. Overtraining has been suggested to cause an imbalance between sympathetic and parasympathetic nerves, or im-

balance of the autonomic nervous system, at an initial stage [7]. Fatigue and lack of motivation are thought to be caused by parasympathetic disorder, and being unsettled and easily excited to be caused by sympathetic disorder. Imbalance of the autonomic nervous system, as evidenced by such symptoms as lack of sleep, triggered by stress from group living during camp training, time difference and training overseas was also observed during the present investigation.

A study by Murphey et al. [8] examined the psychological condition and performance of Judo players who performed a 10-week training program consisting of basic resistance, interval and Judo training during the first 4 weeks, followed by resistance and interval training the amount of which was increased by 50% and base-level Judo training during the next 4 weeks, and then by Judo-focused training, base-level resistance training and under-base-level interval training during the final 2 weeks. Results showed that performances of isokinetic muscle strength and anaerobic endurance decreased while POMS A-H and F scores increased during the period when the amount of training was increased, and thus indicated a correlation of POMS scores to the physical performance of Judo players. The POMS scales that most sensitively change according to amount of training appear to be F and V [9]. In the present study, the V score showed no significant change between the days with the lowest and highest heart rates, which was consistent with Murphey et al.'s study [8]. Meanwhile, the F and C scores were significantly higher on the day with the highest heart rate than on the day with the lowest heart rate. Athletes in good condition often show a high V score and low scores for T-A, D, A-H, F and C, and this pattern of POMS scores is known as the "iceberg profile", while under an excessive training load, POMS shows a pattern known as the "inverted iceberg profile", with a low V score and high scores for T-A, D, A-H, F and C [10,11]. The present study has revealed correlations between an increase in heart rate and increases in F and C scores, indicating that an increase in heart rate negatively affects POMS scales.

In summary, the results of the present study have revealed correlations between heart rate on rising and several psychological factors. Although psychological con-

dition tends to be considered less serious than physical condition, poor psychological conditioning can cause such problems as lack of sleep, which can lead to an imbalance of the autonomic nervous system and eventually to impairment of physical condition. Although POMS-based assessment of condition is useful, it is very difficult to use it for conditioning assessment during an actual international competition or strenuous training camp, since it requires subjects to answer many questions. Measurement of heart rate on rising is simple and reflects both physical and psychological conditions, and therefore is useful for assessment of overall condition. In efforts to improve international competitive power, there will be an increasing opportunity for young Japanese Judo players to participate in overseas training camp programs. Many under-age players, in particular, are not able to manage their conditions on their own and it is therefore important for coaches and supervisors to understand and manage the overall condition of these players based on such measures as heart rate on rising. It may also be possible to develop players' interest in and habit of managing their condition on their own by promoting them to undertake such activities as measuring their heart rate.

## CONCLUSIONS

In the present study, with the aim of ascertaining Judo players' physical and mental condition during an overseas training camp, we measured heart rate on rising, sleep length, physical and mental condition, and POMS scores, determined the days with the lowest and highest heart rates, and examined the relationships between heart rate on rising and other factors.

As heart rate on rising increased, sleep length shortened and physical and mental conditions worsened.

As heart rate on rising increased, scores for POMS Fatigue (F) and Confusion (C) scales increased.

Measurement/management of heart rate on rising is useful for ascertaining the physical and mental conditions of Judo players participating in overseas training camp programs and international competitions.

## REFERENCES:

1. Fry RW, Morton AR, Keast D: Overtraining in athletes. An update. *Sports Med*, 1991; 12: 32-65
2. Stone, MH, Keith RE, Keamey JT et al: Overtraining: a review of the signs, symptoms and possible causes. *Journal of Applied Sports Science Research*, 1991; 5: 35-50
3. Dressendorfer RH, Wade CE, Scaff JH: Increased morning heart rate in runners: a valid sign of overtraining? *Physician and Sportsmedicine*, 1985; 13: 77-86
4. Suzuki N, Sato S, Kasugai A et al: Psychological condition evaluation in high-intensity training camp in judo athletes. *Bulletin of the Association for the Scientific Studies on Judo, Kodokan*, 2007; 6: 93-98
5. Yoshioka Y, Umeda T, Nakaji S et al: Gender differences in the psychological response to weight reduction in judoists. *Int J Sport Nutr Exerc Metab*, 2006; 16: 187-98
6. Kanakis C, Hickson RC: Left ventricular responses to a program of lower-limb strength training. *Chest*, 1980; 78: 618-21
7. Israel S: Zur problematik des ubertrainings aus internistischer und leistungsphysiologischer sicht. *Medizin und Sport*, 1980; 16: 1-12 [in German]
8. Murphy SM, Fleck SJ, Dudley G, Callister R: Psychological and performance concomitants of increased volume training in elite athletes. *Journal of Applied Sport Psychology*, 1990; 2: 34-50

9. Raglin JS, Morgan WP, O'Connor PJ: Changes in mood states during training in female and male college swimmers. *Int J Sports Med*, 1991; 12: 585-89
10. Morgan WP, Brown DR, Raglin JS, O'Connor PJ, Ellickson KA: Psychological monitoring of overtraining and staleness. *Br J Sports Med*, 1987; 21: 107-14
11. Morgan WP, Costill DL, Flynn MG, Raglin JS, O'Connor PJ: Mood disturbance following increased training in swimmers. *Med Sci Sports Exerc*, 1988; 20: 408-14