

# Changes in stress and recovery in elite rowers during preparation for the Olympic Games

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## ABSTRACT

KELLMANN, M., and K-D. GÜNTHER. Changes in stress and recovery in elite rowers during preparation for the Olympic Games. *Med. Sci. Sports Exerc.*, Vol. 32, No. 3, pp. 676–683, 2000. **Purpose:** The purpose was to investigate changes in stress and recovery during preparation for the 1996 Atlanta Olympic Games. **Methods:** Eleven elite rowers of the German National Rowing Team completed four times the Recovery-Stress-Questionnaire for Athletes (RESTQ-Sport). The eight rowers who competed at the Olympic Games filled out the RESTQ-Sport a fifth time, 2 d before the preliminaries. **Results:** Trend parameters revealed significant alterations of somatic components of stress (Lack of Energy, Somatic Complaints, Fitness/Injury) and recovery factors (Fitness/Being in Shape) over time that mirrored the average length of daily extensive endurance training sessions. Significant changes in the scales Conflicts/Pressure and Social Relaxation reflected interpersonal processes within the team. **Conclusions:** The importance of balancing training stress and recovery for an optimal performance development is highlighted as well as the potential of the RESTQ-Sport for training monitoring. **Key Words:** ROWING, OVERTRAINING

To avoid overtraining and to optimize performance in sports, physical recovery should be addressed systematically (22). The relationship between stress and performance in competition as well as in everyday life has been well investigated (4,10,30). However, the impact of recovery has received comparatively little attention. Goldberger and Breznitz (4) stated that “a crucial but neglected area in understanding stress concerns the temporal characteristics of recovery from stressful encounters” (p. 5). According to the biopsychological stress model by Janke and Wolffgramm (8), stress is an unspecific reaction-oriented syndrome that is characterized by a deviation from the biological homeostatic state of the organism. Stress is accompanied by emotional symptoms like anxiety and anger, elevated activation in the central and autonomous nervous system, humoral responses, changes in immune functions, and behavioral changes. Stress initiates processes of adaptation and coping. In contrast, recovery is far less precisely defined.

Recovery encompasses active processes of reestablishing psychological and physical resources and states that allow the taxing of these resources again (12,14). Recovery has physiological, subjective as well as action-oriented components. Therefore, a differentiation between physical, mood-

related, emotional, behavioral, and social aspects is necessary. Kallus (11) described different features of recovery using a multilevel concept. He postulated recovery to be an individual specific process that occurs over time and depends upon the type and duration of stress. In addition, recovery takes place at different levels of organismic functioning (e.g., physical, psychic, social), and it ends with a psychophysical state of restored efficacy and homeostatic balance. Empirical evidence suggests that recovery is a sensitive process that can easily be disturbed or prevented (13).

In sports, an interaction of stress and recovery has been shown that depends upon the respective activity (21,22). Suitable changes in training volume/intensity and restitution in daily practice that include a temporary short-term fatigue and exertion followed by recovery lead to a long-term performance enhancement (32). Optimal performance is only achievable if athletes are able to recover after competition and optimally balance training stress and adequate recovery (36). The authors pointed out that “too often the recovery element is overlooked as an essential aspect of any training regime” (36, p. 57). As a result of inadequate recovery (deficit and/or disturbances of recovery) psychological and physical consequences such as overtraining and burnout may occur (25,32). Therefore, sufficient recovery during phases of intensive training is needed to prevent athletes from overtraining (7,33).

According to Morgan and colleagues (27), this involves a dynamic, intensive process that is approached in a deliberate and planned manner. Another term that has been used

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interchangeably with overtraining is staleness. Morgan et al. (27) have made an important distinction between these two similar concepts. Whereas overtraining reflects a dynamic process, staleness is an undesirable outcome of overtraining characterized by an inability to train at customary levels, and sometimes accompanied by symptoms like drowsiness, apathy, irritability, fatigue, anxiety, confusion, disturbances in sleep, and clinical depression. One goal of research on overtraining and staleness is to determine indicators that sensitively predict such a negative development (33).

So far, respective research has addressed the relationship of overtraining and mood. This research is mostly based on the Profile of Mood States (POMS; 24). Morgan et al. (27) reported mood changes in swimmers during the season. Early in the season, swimmers displayed the iceberg-profile (26,28), a profile indicative of positive mental health that is associated with successful athletic performance. During overtraining, mood disturbances significantly increased and were accompanied by a profile reflecting diminished mental health. After the training stimulus was significantly reduced, the swimmers again exhibited the original iceberg-profile. More recently, the existence of a dose-response relationship was demonstrated between training volume and mood disturbances (33). Increases in training volume parallel corresponding elevations in mood disturbance (e.g., greater anger, depression, tension, fatigue, and less vigor and well-being). Mood improvements occur if the training volume is reduced (27,29,31,34). Morgan and colleagues (27) recommend that the symptoms associated with overtraining and staleness should be monitored continuously during the course of athletic training so that training volumes can be adjusted as soon as negative symptoms begin to appear.

One approach to monitor training in elite sports is the measurement of the athletes' view of stress and recovery at the same time and to examine the balance/imbalance between these two aspects (18). Restricting the analysis to the stress dimension alone is insufficient, especially in high-performance areas, as the management of training intensity and volume is tightly linked to outstanding performance. The recovery-stress state indicates the extent to which someone is physically and/or mentally stressed as well as whether or not the person is capable of using individual strategies for recovery and which strategies are used. From the perspective of a biopsychological stress model (8), recovery and stress should be treated using a multilevel approach, dealing with psychological, emotional, cognitive behavioral/performance, and social aspects of the problem, considering these aspects both separately and together. The systematic inclusion of recovery and stress scales in the Recovery-Stress-Questionnaire (11) provides the opportunity to demonstrate that both aspects are related to different states of a person.

Because recovery cannot merely be characterized as lack of stress but also as an active individualized process to reestablish psychological and physical resources, the use of the POMS, which is the most frequently used measure, may be insufficient to explore recovery processes. The POMS was initially developed as an economical method of iden-

tifying and assessing transient, fluctuating affective states (24). Consequently, the POMS only vaguely reflect recovery processes. A more detailed assessment of these processes is needed to systematically develop training plans that combine intensive training and recovery in the form of the dynamic, intensive processes demanded. In their review "Overtraining and Recovery," Kenttä and Hassmén (20) stated that the Recovery-Stress-Questionnaire is one of the few psychometric instruments that "attempts to address the full complexities of stress and recovery" (p. 12). Therefore, in this study the state of stress and recovery in elite rowers during high-altitude preparation camp for the 1996 Atlanta Olympic Games was monitored. One purpose of this study was to identify and examine the dose-response relationship between training volume and the recovery-stress state perceived by the German rowers during preparation for the Olympic Games.

## METHODS

**Participants.** The participants in this study were eleven elite rowers (including one male and two female reserve rowers) of the German National Rowing Team who were preparing for the Olympic Games in Atlanta. The anthropometrical data of the 11 team members were: female  $N = 6$ , height: 176 (170–185) cm, weight: 62.75 (57–73) kg, and age: 25.6 (18–30) yr (means and range); male  $N = 5$ , height: 188 (181–192) cm, weight: 78.3 (70–93) kg, and age: 26.2 (21–32) yr (means and range). All participants completed informed consent statements before administration of the Recovery-Stress-Questionnaire for Athletes.

**Instrument.** The Recovery-Stress-Questionnaire for Athletes (RESTQ-Sport; 14) was developed to measure the frequency of current stress along with the frequency of recovery-associated activities. The RESTQ-Sport is constructed in a modular way including 12 scales of the general Recovery-Stress-Questionnaire (11) and additional sport-specific scales (14). The German version of the RESTQ-Sport consists of 77 items (19 scales with four items each plus one warm-up item), which subjects answer retrospectively. A Likert-type scale is used with values ranging from 0 (never) to 6 (always) indicating how often the respondent participated in various activities during the past 3 days/nights. The mean of each scale can range from 0 to 6, with high scores in the stress-associated activity scales reflecting intense subjective strain whereas high scores in the recovery-oriented scales mirror plenty recovery activities.

Table 1 gives an overview of the RESTQ-Sport scales with a sample item, internal consistencies and information which scales are related to stress or recovery, respectively. The first 12 scales were developed in accordance with the multilevel, biopsychological stress model by Janke and Wolffgramm (8). Behavioral- and performance-related items were supplemented by those that address emotional, physical, and social aspects of stress and recovery. The first seven scales tackle different aspects of subjective strain as well as the resulting consequences. General Stress covers unspecific strain reactions that manifested themselves in

TABLE 1. Scales of RESTQ-Sport, the scale orientation (o), number of items (n), a sample item, Cronbach's  $\alpha$ , and test-retest reliabilities.

| No. | RESTQ-Sport Scales      | o | n | Example  | $\alpha$ | Test-Retest |
|-----|-------------------------|---|---|--|----------|-------------|
| 1   | General Stress          | S | 4 | ... I felt down  | 0.76     | 0.71        |
| 2   | Emotional Stress        | S | 4 | ... I was in a bad mood                                  | 0.71     | 0.72        |
| 3   | Social Stress           | S | 4 | ... I was angry with someone                             | 0.85     | 0.77        |
| 4   | Conflicts/Pressure      | S | 4 | ... I felt under pressure                                | 0.68     | 0.73        |
| 5   | Fatigue                 | S | 4 | ... I was overtired                                      | 0.78     | 0.81        |
| 6   | Lack of Energy          | S | 4 | ... I was unable to concentrate well                     | 0.72     | 0.68        |
| 7   | Somatic Complaints      | S | 4 | ... I felt uncomfortable                                 | 0.71     | 0.76        |
| 8   | Success                 | R | 4 | ... I finished important tasks                           | 0.67     | 0.70        |
| 9   | Social Relaxation       | R | 4 | ... I had a good time with my friends                    | 0.80     | 0.74        |
| 10  | Somatic Relaxation      | R | 4 | ... I felt at ease                                       | 0.85     | 0.79        |
| 11  | General Well-being      | R | 4 | ... I was in a good mood                                 | 0.84     | 0.61        |
| 12  | Sleep                   | R | 4 | ... I had a satisfying sleep                             | 0.83     | 0.70        |
| 13  | Disturbed Breaks        | S | 4 | ... my coach demanded too much of me during the breaks   | 0.79     | 0.64        |
| 14  | Emotional Exhaustion    | S | 4 | ... I felt that I wanted to quit my sport                | 0.71     | 0.72        |
| 15  | Injury                  | S | 4 | ... my performance drained me physically                 | 0.78     | 0.59        |
| 16  | Being in Shape          | R | 4 | ... I was in a good condition physically                 | 0.88     | 0.71        |
| 17  | Personal Accomplishment | R | 4 | ... I dealt very effectively with my teammates' problems | 0.80     | 0.81        |
| 18  | Self-Efficacy           | R | 4 | ... I was convinced that I had trained well              | 0.89     | 0.82        |
| 19  | Self-Regulation         | R | 4 | ... I prepared myself mentally for performance           | 0.83     | 0.77        |

$\alpha$ . Pooled samples of the German Junior Rowing National Team of 1995, 1996, and 1997 ( $N = 149$ ); S, Stress; R, Recovery; Test-Retest, Test-retest reliability after 3 d for the sample of the German Junior Rowing National Team of 1998 ( $N = 58$ ).

frequent indications of mental stress, depressed mood, and listlessness. This scale was labeled General Stress due to its consistently high correlation to the remaining stress scales (11). Emotional Stress predominantly deals with questions relating to stress through anxiety, inhibitions, and anger. Social Stress measures the frequency of arguments, fights, irritation concerning others, and being upset. Conflicts/Pressure assesses whether conflicts were unsettled, unpleasant things have to be done, and certain thoughts could not be dissolved. Fatigue deals with being constantly disturbed during important work as well as overfatigue, and overcharge. A Lack of Energy indicates ineffective work behavior like a lack of concentration, energy, and decision making. Somatic Complaints measured by the last stress-oriented scale relates to physical indisposition and physical complaints. Success asks for pleasure at work, having lots of ideas, and success. It is the only resulting recovery-oriented scale which is concerned with performance in general but not in a sport-specific context. Social Relaxation assesses the frequency of pleasurable social contacts and change combined with relaxation and amusement. Somatic Relaxation covers physical relaxation and fitness. Besides the frequency of good mood and high well-being, general relaxation, and being content are assessed by the General Well-being scale. Sleep as the final scale of the general Recovery-Stress-Questionnaire indicates trouble in falling asleep and interrupted sleep (11).

To address more details of stress and recovery in sports, Kellmann and Kallus (14) developed seven additional scales for the RESTQ-Sport that extend the basic scales mentioned above. For example, during the development process item analyses revealed that the conceptualization of Somatic Complaints and Somatic Relaxation seem to be too general for athletes. These scales assess adequately physical complaints and relaxation of the general population. But for athletes more sport-specific oriented questions are needed. Therefore, the scales Fitness/Being in Shape and Fitness/Injury were constructed to reflect the physical fitness of an athlete. The burnout oriented scales Burnout/Emotional Ex-

haustion and Burnout/Personal Accomplishment were developed with close resemblance to the burnout construct, and assess psychological symptoms of burnout (12,23). Maslach and Jackson (23) pointed out that emotional exhaustion is positively and personal accomplishment negatively correlated with burnout. Self-Regulation refers to the use of psychological skills training when preparing for performance (e.g., goal setting, mental training; 38). Disturbed Breaks deals with the problem of recovery deficit and disturbed recovery both of which can impair subsequent performance (17). In addition, Self-Efficacy (1) measures the level of expectation regarding an optimal performance preparation in practice. In comparison with earlier publications (15,18,40), the order of the RESTQ-Sport scales was rearranged for an easier applied use (14). Based on the sport-specific intercorrelations the stress-related scales are followed by the recovery-related scales (see Table 1).

Studies with the German Junior National Rowing Team demonstrated that the RESTQ-Sport in German has acceptable levels of Cronbach's alpha ranging between  $\alpha = 0.67$  and  $\alpha = 0.89$  (Table 1; 14,15,18). Moreover, previous longitudinal studies have shown that the RESTQ-Sport is a sensitive monitor of stress and recovery processes both during training camps and throughout the season (9,16,18,19). The consistently high short-term stability underlines the reliability of the procedure. The 24-h test-retest reliability always lies clearly above  $r = 0.79$  (11). Therefore, it can be assumed that interindividual differences in the recovery-stress state can be well reproduced. Table 1 lists test-retest reliability scores after three days, ranging between  $r = 0.51$  and  $r = 0.81$ . The high test-retest reliability shows that the results of the RESTQ-Sport are stable regarding short-term functionary fluctuations and short-term changes of state. In the case of longer time periods, the correlations decline according to the measurement intention of the questionnaire (11). The intercorrelation of the scales indicates that stress and recovery have to be seen as two partly independent factors, which allows to analyze the data

TABLE 2. Correlations of RESTQ-Sport and the POMS.

| RESTQ-Sport Scales      | POMS Scales |            |       |       |         |           |
|-------------------------|-------------|------------|-------|-------|---------|-----------|
|                         | Tension     | Depression | Anger | Vigor | Fatigue | Confusion |
| General Stress          | 0.65        | 0.64       | 0.62  | -0.53 | 0.71    | 0.47      |
| Emotional Stress        | 0.68        | 0.35       | 0.74  | -0.63 | 0.78    | 0.37      |
| Social Stress           | 0.27        | 0.06       | 0.86  | -0.35 | 0.36    | 0.20      |
| Conflicts               | 0.59        | 0.53       | 0.36  | -0.17 | 0.57    | 0.21      |
| Fatigue                 | 0.57        | 0.37       | 0.29  | -0.42 | 0.78    | 0.29      |
| Lack of Energy          | 0.17        | 0.15       | 0.60  | -0.20 | 0.30    | 0.48      |
| Somatic Complaints      | 0.57        | 0.21       | 0.16  | -0.50 | 0.75    | 0.22      |
| Success                 | 0.04        | 0.07       | 0.06  | -0.04 | 0.02    | -0.10     |
| Social Relaxation       | -0.31       | -0.19      | -0.11 | 0.59  | -0.15   | -0.21     |
| Somatic Relaxation      | -0.50       | -0.32      | -0.34 | 0.54  | -0.50   | -0.47     |
| General Well-being      | -0.57       | -0.41      | -0.25 | 0.60  | -0.58   | -0.32     |
| Sleep                   | -0.35       | 0.01       | -0.18 | 0.48  | -0.24   | -0.03     |
| Disturbed Breaks        | 0.58        | 0.40       | 0.33  | -0.66 | 0.55    | 0.35      |
| Emotional Exhaustion    | 0.64        | 0.52       | 0.17  | -0.43 | 0.60    | 0.36      |
| Injury                  | 0.18        | -0.05      | 0.09  | -0.22 | 0.51    | -0.07     |
| Being in Shape          | -0.13       | 0.07       | 0.08  | 0.34  | 0.04    | 0.07      |
| Personal Accomplishment | -0.19       | -0.24      | 0.08  | 0.22  | 0.05    | -0.10     |
| Self-Efficacy           | -0.36       | -0.34      | 0.05  | 0.41  | -0.18   | -0.32     |
| Self-Regulation         | -0.37       | -0.38      | -0.18 | 0.49  | -0.18   | -0.20     |

Correlations > 0.46 are significant on the  $P < 0.01$  level (one-tailed). Correlations > 0.58 are significant on the  $P < 0.001$  level (one-tailed). Sample: American collegiate swimmers ( $N = 25$ ). Similar results were found for German rowers (14).

on the basis of single scales as well as on the factors stress and recovery (11).

Table 2 provides information about validity of the RESTQ-Sport using the correlational pattern between the RESTQ-Sport and the POMS. To match the reference time of the RESTQ-Sport the heading of the POMS was changed to "in the past 3 days/nights." Only the scale Vigor appears to be positively related to the recovery scales of the RESTQ-Sport, whereas Tension, Depression, Anger, Fatigue, and Confusion are negatively correlated with recovery (see Table 2). *Vice versa*, a positive relationship exists between the stress-related scales of the RESTQ-Sport and Tension, Depression, Anger, Fatigue, and Confusion, whereas Vigor seems to be negatively correlated with stress.

**Procedure.** Participants completed on a regular basis the RESTQ-Sport four times during 3 wk of high-altitude training (T1: arrival at training camp; T2-T3: during training camp; T4: before movement to Atlanta). The eight rowers who competed in Atlanta filled out the RESTQ-Sport a fifth time, 2 d before the preliminaries. Participants completed the questionnaire always after lunch time to keep the time schedule comparable. Throughout preparation all athletes were supervised by coaches of the German Rowing Association, and they practiced with respect to the training schedule administered by this staff.

The training cycle during preparation for major competitions (e.g., Olympic Games, World Championships) consists of extensive and regenerative activities (below 2 mmol·L<sup>-1</sup> blood lactate), intense (2-4 mmol·L<sup>-1</sup> blood lactate), and highly intense (4-8 mmol·L<sup>-1</sup> blood lactate) endurance training, strength training, and speed or tempo training. Running and other types of exercises such as gymnastics or ball games are also a regular part of practice (39). However, endurance training is the mainstay of the rowing program (37,39). Therefore, the average length of daily extensive endurance training in minutes was chosen as appropriate indicator for training volume in high-altitude training camps. In reference to the results of Kellmann and

colleagues (18,19), it was assumed that changes in endurance training are well reflected in the scales of the RESTQ-Sport. It was expected that increases in the duration of endurance training will lead to higher scores in the somatic-related stress scales and lower recovery scales, respectively. *Vice versa*, it was assumed that a decrease of endurance training will be reflected in lower stress and higher recovery scores, respectively.

**Analysis.** Data analysis was conducted using parametric statistics. Means, standard deviations, and changes in scale scores over time were calculated. Changes during the training camp were assessed using trend parameters that were obtained by a data transformation with orthogonal polynomials (3). Because the analysis of the trend-components is a simple data transformation, each of the linear, quadratic, and cubic trend-components counts for (1,10) degrees of freedom, which in sum (global test) is evaluated with (1,30) *df*.

Multiple tests were performed on these change parameters for each scale of the RESTQ-Sport separately without adjustment of type I error and, therefore, results have to be interpreted descriptively. In addition, the data obtained while the athletes were on site in Atlanta were analyzed using paired *t*-tests (two-tailed) to evaluate a change of scoring from the fourth to the fifth measurement. For this procedure, only the data of the eight Olympic athletes who completed both measurements could be analyzed.

## RESULTS

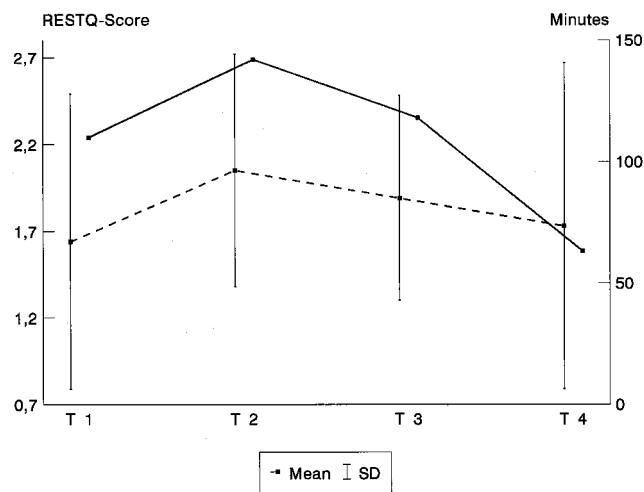
**Changes throughout preparation time in the training camp.** Figure 1 presents changes in participants' scores on the scale Somatic Complaints throughout the four times of measurement and includes the average number of minutes of daily extensive endurance training for the past 3 d to match the reference period of the RESTQ-Sport. Throughout preparation time orthogonal polynomials revealed a significant quadratic trend for the dependent variable Somatic Complaints ( $F(1,10) = 9.65$ ;  $P < 0.05$ ) with



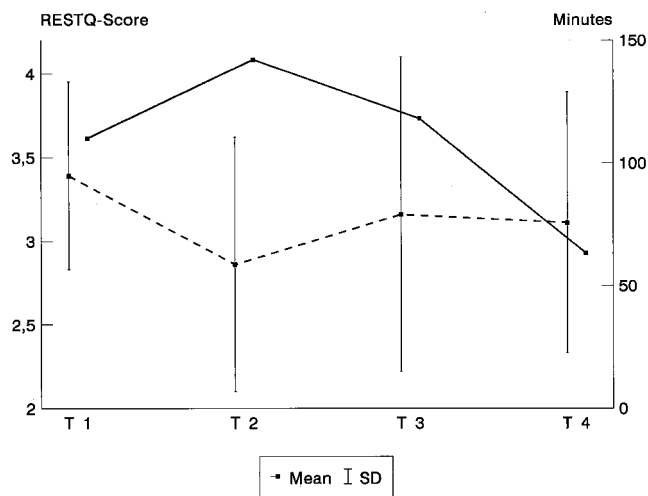
the highest value obtained at the second measurement. Similar trends were found for the scales Lack of Energy [quadratic trend;  $F(1,10) = 7.22$ ;  $P < 0.05$ ], and Fitness/Injury [quadratic trend; ( $F(1,10) = 8.31$ ;  $P < 0.05$ ).

The average number of min of daily extensive endurance training mirrored the trend for Somatic Complaints (see Fig. 1). It increased from low numbers (T1) to a maximum (T2) followed by a decrease (T3, T4) just before the Olympic Games. Results show that the alteration of extensive endurance training was well reflected in psychological measures. High duration is indicated by elevated levels of stress and simultaneous lowered levels of recovery as demonstrated in Figure 2. The recovery-related scale Fitness/Being in Shape changed also with a significant quadratic trend ( $F(1,10) = 5.87$ ;  $P < 0.05$ ) throughout preparation time. However, compared to stress-related scales, the score of Fitness/Being in Shape follows the opposite development with the lowest score at T2. In addition to somatic-related areas (Lack of Energy, Somatic Complaints, Fitness/Being in Shape, Fitness/Injury) the scale Pressure/Conflicts revealed a rise in participant's responses. The scores increased with a significant linear trend from T1 to T4 ( $F(1,10) = 6.57$ ;  $P < 0.05$ ) as the Olympic Games approached. This increasing significant linear trend was found for the scale Social Relaxation ( $F(1,10) = 5.18$ ;  $P < 0.05$ ).

**Change in recovery-stress state before preliminaries.** The recovery-stress state of the eight rowers who competed at the Olympic Games changed from the last measurement during the training camp to the measurement before preliminaries. Overall, an increase in almost all stress-related scales was detected, whereas a decrease of recovery-associated activities was observed (see Fig. 3). The differences in the scales Emotional Stress ( $t(7) = 2.37$ ,  $P = 0.05$ ) and Social Relaxation ( $t(7) = 3.58$ ,  $P < 0.01$ ) turned out to be significant. However, it is appropriate to note the consistent pattern of change resulting in an increase in stress and a simultaneous decrease in recovery activities before the preliminaries.



**Figure 1—Means and standard deviations (SD) of the RESTQ-Sport scale Somatic Complaints (broken line) and the average length of daily extensive endurance training in min (solid line) throughout training camp.**



**Figure 2—Means and standard deviations (SD) of the RESTQ-Sport scale Fitness/Being in Shape (broken line) and the average length of daily extensive endurance training in minutes (solid line) throughout training camp.**

## DISCUSSION

The RESTQ-Sport allows the assessment of subjective stress and recovery during training cycles for major competitions and throughout the season (9,14,15,18,19). The present results suggest that a dose-response relationship exists between training volume, indicated by the average number of minutes of daily extensive endurance training and the subjective assessment of somatic components of stress and recovery. High duration is indicated by elevated levels of stress and simultaneous lowered levels of recovery. This matches the findings of Kellmann and colleagues (18) that the average number of daily rowed kilometers was chosen as indicator for training volume. It also is in line with the results of Morgan and colleagues (27,31,35), who found that increases in training volume parallel corresponding elevations in mood disturbance and mood improvements occur if training is reduced. Additionally, the dose-response relationship between training and mood disturbance is well documented in speed skaters (5), wrestlers (27), runners (41), and rowers (34).

By using the RESTQ-Sport, the somatic components of stress and recovery such as Somatic Complaints, Lack of Energy, Fitness/Injury, and Fitness/Being in Shape reflect the described dose-response relationship (see Figs. 1 and 2). Several other areas of the questionnaire, such as Conflicts/Pressure or Social Relaxation, exhibited the current situation of the team and of individual members. The changes in Social Relaxation may have reflected the influence of team-building activities that were taking place. Besides practice, team building (2,6) was one of the purposes of the training camp. One approach of the coaches was to increase the number of social activities (e.g., sightseeing tours, barbecue, and socializing among the whole rowing team) during free practice time.

The multilevel concept of recovery (11,14,15) may explain the different trends for Social Relaxation and Fitness/Being in Shape even if both scales are recovery related. The

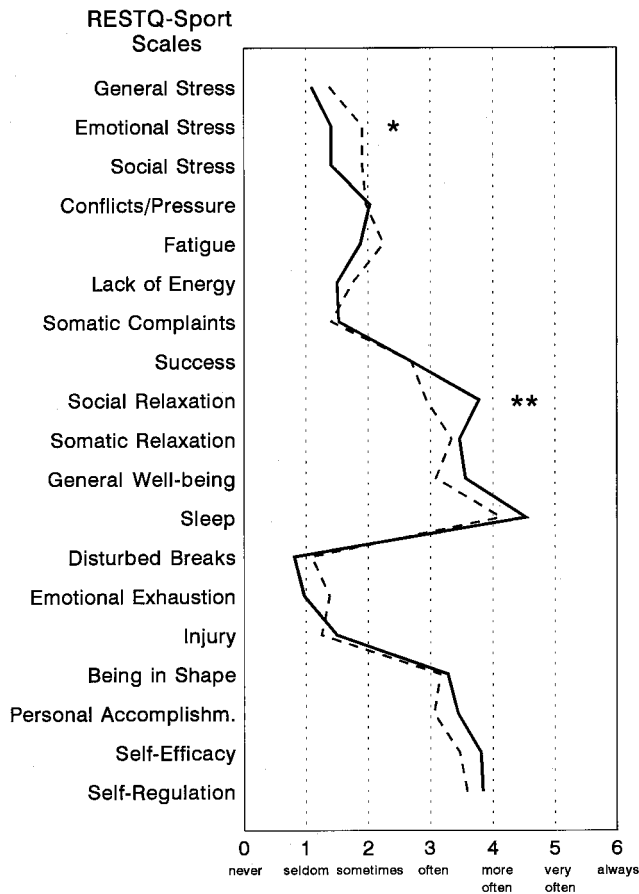


Figure 3—RESTQ-Sport profiles ( $N = 8$ ) for the last measurement in the training camp (T4, solid line) and before preliminaries (T5, broken line). \*  $P \leq 0.05$ ; \*\*  $P < 0.01$ .

RESTQ-Sport includes behavioral and performance related items as well as those which address emotional, physical, and social aspects of stress and recovery. Fitness/Being in Shape refers to the physical level of recovery, Social Relaxation deals with the social level such as group processes and social activities. The significant decrease of Social Relaxation refers to the drop of explicit social activities which took place during the training camp. The relevance of the different trends in the RESTQ-Sport scales is supported by a study of Steinacker and colleagues (40) that shows different time courses of hormones and corresponding scales. Their findings reveal that Somatic Complaints are highest with the highest training load and elevated cortisol concentrations as well as CK activity, but are lower when Fatigue scores increase (40). Additionally, Fatigue peaks together with sympathetic activation (noradrenaline secretion). In general, Somatic Complaints, Fatigue, Social Relaxation, and other scales of the RESTQ-Sport showed different time courses reflecting the current psychological and physiological recovery-stress state.

The consistent increase in stress and a simultaneous decrease in recovery activities of the recovery-stress state from the last measurement during the training camp to the assessment before preliminaries reflects the approach of the 1996 Atlanta Olympic Games. Overall, the performance of the rowers did not meet their expectations. To illustrate

differences in the recovery-stress state, the profiles for two rowers who completed the RESTQ-Sport two days before the preliminaries are shown in Figure 4. The solid line represents rower A, a member of the boat that won the only medal of this sample; the boat of rower B (broken line) finished 13th. In direct comparison, the medal winner showed a more positive recovery-stress state indicated by lower scores of Fatigue, Lack of Energy, and Somatic Complaints, as well as higher scores of Fitness/Being in Shape, Burnout/Personal Accomplishment, Self-Efficacy, and Self-Regulation than rower B. Considering that the measurement took place 9 d before the finals, it may be argued that the assessment was too long back to make it a reliable performance prediction. However, from the applied point of view, the pattern of rower B indicated limitations during the preparation for the upcoming races, whereas rower A showed no handicap. Unfortunately, the RESTQ-Sport data were not analyzed in Atlanta and, therefore, no approach was taken to intervene for a better recovery-stress state of rower B.

It should be pointed out that the RESTQ-Sport assesses mood oriented stress- and recovery-associated activities using items such as "... I was angry with someone" or "... I had a good time with my friends" (see Table 1). In other words, basically the RESTQ-Sport asks the question: What happened in the past 3 days/nights? This demonstrates quite

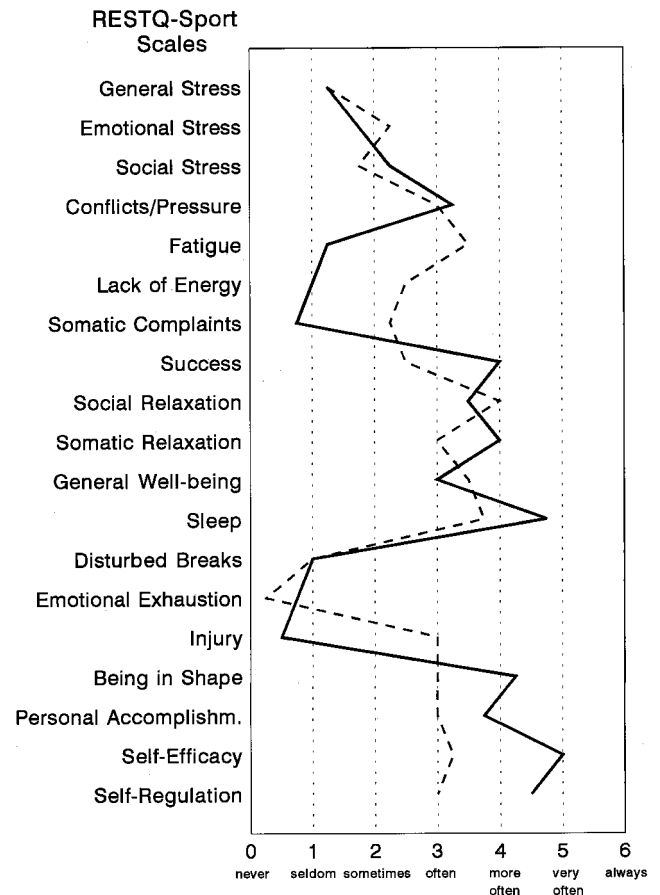


Figure 4—RESTQ-Sport profiles for rower A (solid line) and rower B (broken line) 2 d before preliminaries.

well the difference to the POMS, which just assesses the current mood state and, therefore, shows no specific starting points for intervention. On the other hand, because the RESTQ-Sport deals with mood oriented activities the consultant gets a clear picture of what happened during the past days for groups and/or for individuals. Single case profiles of the recovery-stress state provide precise starting points to work with the athlete on an individual basis (Fig. 4; 14,15,18). In addition, general and/or sport-specific activities also can be considered as a mediator for mood states, which is supported by the considerable high correlations of the RESTQ-Sport and the POMS.

## CONCLUSION

In summary, the POMS was successfully used in most studies dealing with overtraining and mood. However, one specific feature of the RESTQ-Sport is the simultaneous assessment of subjective stress- and recovery-associated activities. Referring to the statement of Rowbottom and colleagues (36), who pointed out that the recovery element is overlooked as an essential aspect of any training regime, the RESTQ-Sport is an potential tool to monitor both stress and recovery processes. It should always be considered that recovery is an active process to reestablish psychological and physical resources. The knowledge of the importance of active recovery gives an athlete more power and responsibility for own activities. This knowledge may effect psy-

chological, emotional, cognitive behavioral/performance, and social aspects of their life. This is crucial during regular training but even more relevant during preparation camps, when the focus often is on monotonous practicing. The aim of each recovery activity should be to restore homeostasis and allow the adaptation of the individual to stress.

Henschen (7) and Raglin (33) stated that adequate recovery during phases of intensive training prevent athletes from overtraining. During the training process the state of physical stress and recovery has to be monitored to prevent overtraining, staleness, and burnout (25). The RESTQ-Sport allows one form for the estimation of the extent of stress and recovery. The results provide athletes and coaches with information that can prove helpful in the training process. Assessments may also be important during times of performance stagnation in order to assist athletes and coaches in determining whether training intensity should be increased or decreased.

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The English translation of the published German manual of the RESTQ is available upon request from the author. The English translation shows comparable Cronbach's Alphas as the German version.

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## REFERENCES

- BANDURA, A. Self-efficacy: toward a unifying theory of behavioral change. *Psychol. Rev.* 84:191-215, 1977.
- CARRON, A. V., K. S. SPINK, and H. PRAPAVESSIS. Team building and cohesiveness in the sport and exercise setting: use on indirect intervention. *J. Appl. Sport Psychol.* 9:61-72, 1997.
- FERGUSON, G. A., and Y. TAKANE. *Statistical Analysis in Psychology and Education*. New York: McGraw-Hill, 1989, pp. 587.
- GOLDBERGER, L., and S. BREZNITZ. Stress research at a crossroads. In: *Handbook of Stress*, L. Goldberger and S. Breznitz (Eds.). New York: Free Press, 1993, pp. 3-6.
- GUTTMANN, M. C., M. POLLOCK, C. FOSTER, and D. SCHMIDT. Training stress in Olympic speed skaters: a psychological perspective. *Physician Sportsmed.* 12:45-57, 1984.
- HARDY, C. J., and R. K. CRACE. Foundations of team building: introduction to a team building primer. *J. Appl. Sport Psychol.* 9:1-10, 1997.
- HENSCHEN, K. Athletic staleness and burnout: diagnosis, prevention, and treatment. In: *Applied Sport Psychology*, J. Williams (Ed.). Mountain View, CA: Mayfield, 1993, pp. 328-337.
- JANKE, W., and J. WOLFFGRAMM. Biopsychologie von Stress und emotionalen Reaktionen: Ansätze interdisziplinärer Kooperation von Psychologie, Biologie und Medizin [Biopsychology of stress and emotional responses: starting points of an interdisciplinary cooperation of psychology, biology, and medicine]. In: *Biopsychologie von Stress und emotionalen Reaktionen [Biopsychology of Stress and Emotional Reactions]*, G. Debus, G. Erdmann, and K. W. Kallus (Eds.). Göttingen: Hogrefe, 1995, pp. 293-347.
- JOHNSON, M. S., C. A. WRISBERG, M. KELLMANN, and K. W. KALLUS. Assessing stress and recovery in collegiate athletes. *J. Appl. Sport Psychol.* 8:S113, 1997.
- JONES, G. J., and L. HARDY. *Stress and Performance in Sport*. New York: Wiley, 1990, pp. 301.
- KALLUS, K. W. *Der Erholungs-Belastungs-Fragebogen [The Recovery-Stress-Questionnaire]*. Frankfurt: Swets and Zeitlinger, 1995, pp. 55.
- KALLUS, K. W., and M. KELLMANN. Burnout in athletes and coaches. In: *Emotions in Sport*, Y. Hanin (Ed.). Champaign, IL: Human Kinetics, 2000, pp. 209-230.
- KALLUS, K. W., and J. KRAUTH. Nichtparametrische Verfahren zum Nachweis emotionaler Reaktionen [Nonparametric methods for the proof of emotional reactions]. In: *Biopsychologie von Streß und emotionalen Reaktionen [Biopsychology of Stress and Emotional Reactions]*, G. Debus, G. Erdmann, and K. W. Kallus (Eds.). Göttingen: Hogrefe, 1995, pp. 23-43.
- KELLMANN, M., and K. W. KALLUS. *Der Erholungs-Belastungs-Fragebogen für Sportler [The Recovery-Stress-Questionnaire for Athletes]*. Frankfurt: Swets and Zeitlinger, 2000, pp. 48.
- KELLMANN, M., and K. W. KALLUS. Mood, recovery-stress state, and regeneration. In: *Overload, Fatigue, Performance Incompetence, and Regeneration in Sport*. M. Lehmann, C. Foster, U. Gastmann, H. Keizer, and J. M. Steinacker (Eds.). New York, NY: Plenum, 1999, pp. 101-117.
- KELLMANN, M., and K. W. KALLUS. The Recovery-Stress-Questionnaire: a potential tool to predict performance in sports. In: *Movement and Sport: Psychological Foundations and Effects*, J. R. Nitsch and R. Seiler (Eds.). Sankt Augustin: Academia, 1993, pp. 242-247.
- KELLMANN, M., and K. W. KALLUS. Interrelation between stress and coaches' behavior during rest periods. *Percept. Mot. Skills* 79:207-210, 1994.
- KELLMANN, M., K. W. KALLUS, K-D. GÜNTHER, W. LORMES, and J. M. STEINACKER. Psychologische Betreuung der Junioren-Nationalmannschaft des Deutschen Ruderverbandes [Psychological consultation of the German Junior National Rowing Team]. *Psychologie und Sport* 4:123-134, 1997.

19. KELLMANN, M., K. W. KALLUS, J. M. STEINACKER, and W. LORMES. Monitoring stress and recovery during the training camp for the Junior World Championships in Rowing. *J. Appl. Sport Psychol.* 9:S114, 1997.
20. KENTÄ, G., and P. HASSMÉN. Overtraining and recovery. *Sports Med.* 26:1–16, 1998.
21. KUIPERS, H., and H. A. KEIZER. Overtraining in elite athletes. *Sports Med.* 6:79–92, 1988.
22. LEHMANN, M., C. FORSTER, and J. KEUL. Overtraining in endurance athletes: a brief review. *Med. Sci. Sports Exerc.* 25:854–861, 1993.
23. MASLACH, C., and S. E. JACKSON. *Maslach Burnout Inventory*. Palo Alto, CA: Consulting Psychologists Press, 1986, pp. 34.
24. McNAIR, D., M. LORR, and L. F. DROPPELMANN. *Profile of Mood States Manual*. San Diego: Educational and Industrial Testing Service, 1992, pp. 40.
25. MEYERS, A. W., and J. P. WHELAN. A systemic model of understanding psychological influences of overtraining. In: *Overtraining in Sport*, R. B. Kreider, A. C. Fry, and M. L. O'Toole (Eds.). Champaign, IL: Human Kinetics, 1998, pp. 335–369.
26. MORGAN, W. P. Selected psychological factors limiting performance: a mental health model. In: *Limits of Human Performance*, D. H. Clarke and H. M. Eckert (Eds.). Champaign, IL: Human Kinetics, 1985, pp. 70–80.
27. MORGAN, W. P., D. R. BROWN, J. S. RAGLIN, P. J. O'CONNOR, and K. A. ELLICKSON. Psychological monitoring of overtraining and staleness. *Br. J. Sport Med.* 21:107–114, 1987.
28. MORGAN, W. P., and D. L. COSTILL. Selected psychological characteristics and health behaviors of aging marathon runners: a longitudinal study. *Int. J. Sport Med.* 17:305–312, 1996.
29. MORGAN, W. P., D. L. COSTILL, M. G. FLYNN, J. S. RAGLIN, and P. O'CONNOR. Mood disturbance following increased training in swimmers. *Med. Sci. Sports Exerc.* 20:408–414, 1988.
30. NEUFELD, R. W. J. (ED.). *Advances in the Investigation of Psychological Stress*. New York: Wiley, 1989.
31. O'CONNOR, P. J., W. P. MORGAN, and J. S. RAGLIN. Psychobiologic effects of 3 d of increased training in female and male swimmers. *Med. Sci. Sports Exerc.* 23:1055–1061, 1991.
32. O'TOOLE, M. L. Overreaching and overtraining in endurance athletes. In: *Overtraining in Sport*, R. B. Kreider, A. C. Fry, and M. L. O'Toole (Eds.). Champaign, IL: Human Kinetics, 1998, pp. 3–17.
33. RAGLIN, J. S. Overtraining and staleness: psychometric monitoring of endurance athletes. In: *Handbook of Research on Sport Psychology*, R. B. Singer, M. Murphey, and L. K. Tennant (Eds.). New York: Macmillan, 1993, pp. 840–850.
34. RAGLIN, J. S., W. P. MORGAN, and A. E. LUCHSINGER. Mood state and self-motivation in successful and unsuccessful women rowers. *Med. Sci. Sports Exerc.* 22:849–853, 1990.
35. RAGLIN, J. S., W. P. MORGAN, and P. J. O'CONNOR. Changes in mood state responses during training in female and male college swimmers. *Int. J. Sports Med.* 12:585–589, 1991.
36. ROWBOTTOM, D. G., D. KEAST, and A. R. MORTON. Monitoring and preventing of overreaching and overtraining in endurance athletes. In: *Overtraining in Sport*, R. B. Kreider, A. C. Fry, and M. L. O'Toole (Eds.). Champaign, IL: Human Kinetics, 1998, pp. 47–66.
37. SECHER, N. H. Physiological and biomechanical aspects of rowing. *J. Sports Med.* 15:24–42, 1993.
38. SEILER, R. Performance enhancement: a psychological approach. *Sport Sci. Rev.* 1:29–45, 1992.
39. STEINACKER, J. M. Physiological aspects of training in rowing. *Int. J. Sports Med.* 14:S3–S10, 1993.
40. STEINACKER, J. M., M. KELLMANN, B. O. BÖHM, et al. Clinical findings and parameters of stress and regeneration in rowers before World Championships. In: *Overload, Fatigue, Performance Incompetence, and Regeneration in Sport*, M. Lehmann, C. Foster, U. Gastmann, H. Keizer, and J. M. Steinacker (Eds.). New York: Plenum, 1999, pp. 71–81.
41. WITTIG, A. F., J. A. HOUMARD, and D. L. COSTILL. Psychological effects during reduced training in distance runners. *Int. J. Sports Med.* 10:97–100, 1989.