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# Relationships between Self-Rating of Recovery from Work and Morning Salivary Cortisol

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**Abstract: Relationships between Self-Rating of Recovery from Work and Morning Salivary Cortisol: Klas GUSTAFSSON, *et al.* Department of Psychology, Stockholm University, Sweden**—To date, the understanding of how recovery from work relates to cortisol output is poor. Considering this, the present study set out to investigate the associations between self-ratings of 15 items of rest and recovery and salivary cortisol sampled every second hour across two working days. Data came from 12 female and 13 male white-collar workers and were analyzed by linear regression analyses and repeated measures ANOVA. Poor rest and recovery was associated with high levels of morning cortisol, with the strongest relationships emerging for "rested in the morning", "rested after a weekend", "feel energetic during the working day", "tired during the working day", "sufficient sleep" and "worry about something". Moreover, significant interaction effects emerged between sex and "rested after a weekend" and "worry about something". To conclude, the findings show that self-ratings of rest and recovery are related to cortisol, particularly to morning cortisol, and that self-ratings provide important information on physiological recovery in terms of cortisol output.
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**Key words:** Recovery, Self-ratings, Salivary cortisol, Allostatic load

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Lack of recovery, or poor unwinding, has been proposed as a key factor relating to the increasing levels of stress-related health problems among working women and men in industrialized countries[1–4]. This is based on research showing the inability to rest and recover from work having negative effects on individual health and well being. For instance, insufficient recovery has been associated with poor psychological and physical health, in terms of symptoms and burnout[5, 6]. However, the understanding of the physiological mechanisms underlying the associations between poor recovery and health-related problems is poor.

To describe the relationships between physiology and recovery, reliable methods to measure rest and recovery are needed. One of the most common methods to gain information on rest and recovery is to ask people to provide self-ratings in questionnaires. To determine whether answers to such questions are associated with health, self-ratings can be evaluated with respect to established biomarkers of physiological functioning, such as cortisol. Previous research[4, 7] suggests that cortisol is associated with rest and recovery, but the hypothesis remains to be investigated[6].

Rest and recovery are fundamental to the allostatic load model that describes how the bodily systems strive to achieve stability and adaptation through change[2, 3, 8]. According to the allostatic load model, health-related problems can result from too high or too frequently recurring physiological activation, or from an inability to shut off physiological activation when the stress exposure has ended[2, 3]. This means that recurring and long-term stress-related activation of various physiological systems, without any possibility for rest and recovery, adds to the wear and tear of the body's resources thereby increasing the risk for future health problems[2, 3]. With respect to recovery from work, incomplete or insufficient recovery has been associated with an increased risk for allostatic load[9].

Stress activates two important body systems: the sympatho-adreno-medullary (SAM) system and the hypothalamo-pituitary-adrenocortical (HPA) axis[2, 3]. The SAM-system, acts via the sympathetic nervous system and the adrenal medulla, which secretes adrenaline and

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noradrenaline and triggers the fight and flight response. The HPA-axis acts via the pituitary gland and cortex of the adrenal medulla, which releases cortisol. This hormone helps to maintain the body's defence against stress and its resistance to inflammation and is involved in the defeat response[1, 3, 8, 10–12]. The SAM-system and the HPA-axis interact, and like other physiological systems, they are flexible and their activation levels can change dramatically during short or long periods of time. Paralleling the increased activity within these two systems is the temporary turning down of anabolic processes, such as digestion and the production of growth and sex hormones[1–3]. As for the relationships between cortisol and stress, previous research[13–18] has shown that working women and men who report high levels of stress typically exhibit high cortisol levels, particularly in the morning hours. Conversely, high levels of psychological well-being have been related to moderate cortisol levels.

This study is part of a larger project, with the overall aim of studying modern working life in which people must themselves regulate their working hours and assume responsibility for their work[19]. Using a self-report measure of 15 items of rest and recovery from work, the present study set out to investigate the predictive value of each item on salivary cortisol. Drawing on previous research[4], poor rest and recovery were hypothesized to be associated with higher levels of morning cortisol.

## Method

*Participants*

The participants were part of a group of 169 employees of a government authority who were invited to participate in a study. Employees who were on parental leave, sick listed or worked mainly at another location were excluded. The remaining 120 employees were given a questionnaire (see Procedure), which was completed by a total of 107 participants (response rate 89%). The information collected via the questionnaire was used to recruit individuals to participate in a psychophysiological study, which among other things included measurements of salivary cortisol. Individuals who did not provide important demographic data, as well as part-time employees (n=16), those with illnesses that demanded medical treatment, and pregnant women were excluded. The remaining participants (n=56) were contacted via telephone and invited to take part in the study. Of these, 14 declined because participation in the study conflicted with other activities (meetings, trips, family situation, etc.), and four declined due to changes in their work situation. Twelve individuals could not be reached by mail or telephone. When the psychophysiological study was conducted and the cortisol tests were analyzed, one individual was excluded due to greatly deviating cortisol values compared to the other study participants (*i.e.*, outlier). The final healthy study group consisted of 13 men and 12 women (n=25) aged between 24 and 62 yr. The men (M=40.1 yr, SD=12.5) were somewhat younger than the women (M=41.7 yr, SD=11.2). All participants except for one woman were white-collar workers with degrees from either a university or a university college. All of them were full-time employed and worked ordinary office hours (day time). For further details, see Lundberg and Lindfors[20].

*Procedure*

Prior to the sampling of salivary cortisol, all participants completed a questionnaire that, in addition to other questions, asked for details on demographic information and rest and recovery (for details, see Lundberg and Lindfors[20–22]. Measurements of salivary cortisol were carried out individually on two working days according to oral and written instructions from the investigators. Saliva samples were collected six times each day with the first sample being obtained 15–30 min after waking with continued self-administered sampling approximately every second hour throughout both sessions, ending at 8 p.m. To reduce intra-individual variation in circadian rhythm, all participants were asked to rise and go to bed at the same times during the different days of measurement. Self-ratings of rest and recovery and sampling of saliva were performed on different days, and the entire data collection took place over a period of approximately six months. The study was approved by a research ethics committee[20].

*Questionnaire*

Rest and recovery from work. The items were formulated to describe rest and recovery from work in terms of feelings of rest, recovery and fatigue, problems sleeping, work-related worry and discomfort. These items have been used in several previous studies[9, 23–25]. Internal consistency (Cronbach's alpha) for all 15 rest and recovery items included in this study was 0.85.

*Cortisol*

The saliva samples were collected in plastic tubes (Salivette; Sarstedt Inc., Rommelsdorf, Germany) that contain a cotton roll. Participants were instructed not to brush their teeth, eat, drink or smoke 15 min before collecting the saliva. For each sample, they were asked to note date and time of the day. Minor differences existed in time of awakening and time of saliva sampling between the individuals. However, these differences were not assumed large enough to have markedly influenced the results. The saliva samples were stored in a freezer (–18°C) until centrifuged and analyzed by radioimmunoassay (RIA).

*Statistical analyses*

To eliminate the effect of partial missing of nine cortisol

**Table 1.** Result of linear regression of 15 questions concerning rest and recovery on cortisol at two points in the morning. Regression coefficients (Beta) show the change of cortisol level (pmol/m*l*) for each scale position

| Item | Rest and recovery questions | Morning cortisol 7:00 (15–30 min after awakening) Beta | 9:00 Beta |
|---|---|---|---|
| | **Recovered/rested** | | |
| E6[a] | Do you feel thoroughly rested when you start working in the morning? | 1.8** | 1.5** |
| E11[a] | Do you feel rested and recovered when you return to work after a weekend? | 2.7/–0.8[#] | 1.4* |
| E12[a] | Do you feel rested and recovered when you return to work after a medium term absence (e.g., long weekend, short vacation)? | 1.2 | 1.4* |
| E13[a] | Do you feel rested and recovered when you return to work after several weeks' leave from work or vacation? | –0.3 | 0.9 |
| | **Fatigue** | | |
| E8[a] | Do you feel energetic during a working day? | 3.7** | 2.9** |
| E7[a] | Do you feel very tired during the working day? | 3.0** | 2.2** |
| E10[a] | Do you experience mental fatigue after a working day? | –1.3 | –1.0 |
| E9[a] | Do you experience physical fatigue after a working day? | 0.1 | –0.1 |
| | **Sleep problems** | | |
| E17[b] | Upon waking during the past week, how often have you felt that you have had sufficient sleep? | 2.6** | 1.8* |
| E16[c] | During the past week, have you had difficulties sleeping (difficulties falling asleep, waking too early due to work) because work-related thoughts have kept you awake? | 0.7 | 0.3 |
| E14[a] | During the past three months, have you had difficulties sleeping because work-related thoughts have kept you awake? | 0.1 | –0.1 |
| E 19[d] | How many hours a night do you normally sleep? | –0.2 | –0.6 |
| E18[e] | How well do you normally sleep? | –0.1 | –0.5 |
| | **Worry/discomfort** | | |
| E144B[f] | I often worry about something. | 4.1/1.2[#] | 1.7** |
| E15[g] | Do you sometimes feel uneasy on your way to work? | 1.2 | 1.2* |

* $p<0.05$; ** $p< 0.01$. [#] Interaction effect with sex ($p<0.05$) beta coefficients (women/men).
a. Very often (1), Quite often (2), Sometimes (3), Seldom (4), Never (5). Question E7 was reversed in the statistical analysis and Fig. 1.
b. No mornings (1), Some mornings (2), Most mornings (3), All mornings (4). The item was reversed in the statistical analysis and Fig. 1.
c. Not at all (1), One night (2), Some nights (3), Every night (4).
d. Number of hours.
e. Very poorly (1), Quite poorly (2), Varies (3), Quite well (4), Very well (5).
f. Scale from 1 to 5: Disagree completely (1), Agree completely (5).
g. Not at all (1), Seldom (2), A few days per month (3), One day per week (4), A couple of days per week (5), Every day (6).

values, nine out of 300 cortisol values were imputed. Missing values were replaced with an individual average value based on the value immediately before and after the missing value.

Based on each of the six measurements during the two days, the average concentration of cortisol (pmol/m*l*) was calculated for each point in time. Using linear regression analysis adjusting for sex and age, the associations between self-ratings and cortisol were quantified and used to predict cortisol values in pmol/m*l* for each of the items. In addition, self-ratings for each item were used to dichotomize the sample into groups of recovered and non-recovered individuals. This categorization was used in repeated measures ANOVA (parameter estimates, *t*-tests), to analyze the average value differences in salivary cortisol levels for each item. These analytic strategies are often used in psychological research on linkages between biomarkers, such as cortisol, and self-ratings[13, 15, 26].

## Results

Table 1 shows the regression (Beta) coefficients from linear regression between self-ratings of rest and recovery

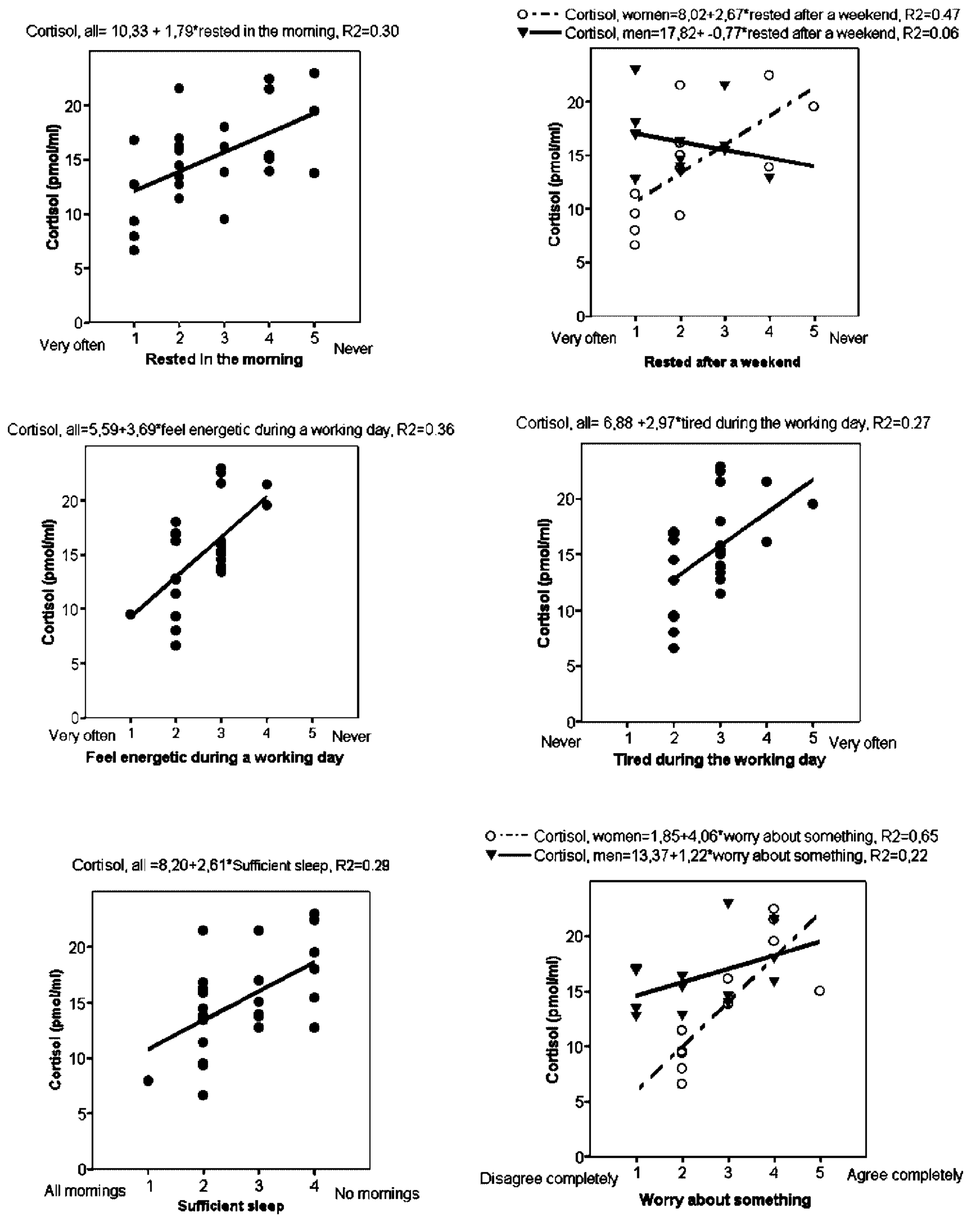


**Fig. 1.** Regression coefficients (Beta) for morning cortisol (15–30 min after waking) and self-ratings for six items producing significant results ($p<0.01$).

items and morning cortisol at the first two points in time (circa 7 am and 9 am) for the study group (n=25). Figure 1 shows self-ratings of these six items in relation to cortisol, and the regression equations. For age, there was only a small effect on the association between "worry about something" and morning cortisol, while none of the analyses showed significant interaction effects with age. However, for sex, significant interaction effects ($p<0.05$) were found at time point 1 (15–30 min after waking, *i.e.*, morning cortisol) for the items "rested after a weekend" and "worry about something". As regards "rested after a weekend", higher regression coefficients (2.7) emerged for women than for men (–0.8). The women also had higher regression coefficients (4.1) on

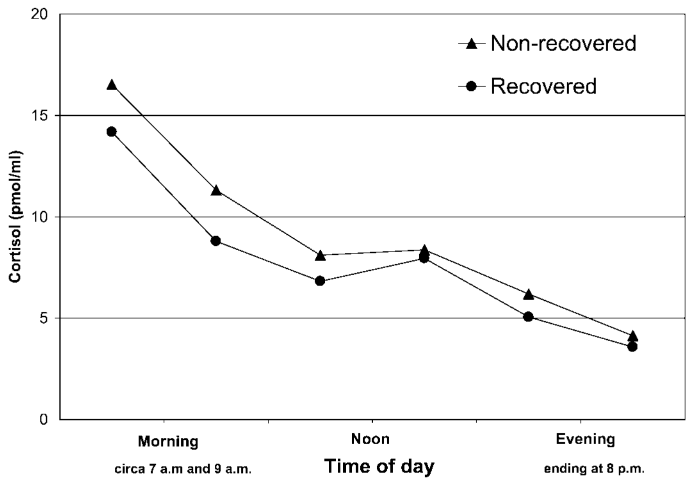


**Fig. 2.** Mean values of salivary cortisol (pmol/m*l*) from morning to evening for groups of recovered and non-recovered individuals on all items.

the question "worry about something" than did the men (1.2).

Table 1 shows that the regression coefficients between salivary cortisol in the morning and four recovery items of varying lengths of recovery period ("rested in the morning", "rested after a weekend", "rested after a medium term absence" and "rested after vacation") decrease by length of recovery period. On the item "rested after vacation", 21 participants answered that they were very often or quite often rested, which implies that almost all participants were recovered: only four participants reported clear recovery problems after vacation.

In comparison with morning cortisol, the regression coefficients for the rest and recovery items and cortisol for other points in time during the day were considerably weaker and had lower significance levels. However, significant regression coefficients ($p$<0.05) were found for morning and afternoon/evening cortisol and for the item "rested after vacation" (0.9), "feel uneasy on your way to work" (1.0–1.2), "sufficient sleep" (–0.7) and "worry about something" (0.9). For the items "rested after a weekend", "rested after a medium term absence" and "rested after vacation" and evening cortisol, there were significant ($p$<0.05) interaction effects with sex (results not included in Table 1).

The results of the regression analyses show that high levels of salivary cortisol in the morning were associated with insufficient recovery. After dichotomization of scores on the 15 items, two distinct groups emerged: the "recovered" and "non-recovered" groups. The recovered group had lower levels of salivary cortisol than did the non-recovered group with this pattern being repeated across all 15 items. Variance analysis showed significant ($p$<0.01) results for morning cortisol for the following items: "rested in the morning", "rested after a weekend", "feel energetic during the working day", "tired during the working day", "sufficient sleep", "feel uneasy on your way to work" and "worry about something". Figure 2 summarizes mean values for cortisol output across all 15 items for the two groups of recovered and non-recovered individuals. As shown in Fig. 2, cortisol levels were high in the morning but decreased quickly during the morning hours and then successively evened out as afternoon and evening approached.

## Discussion

This study set out to investigate how self-ratings of rest and recovery relate to salivary cortisol in a healthy group of women and men, with the results showing clear associations between rest and recovery and salivary cortisol. Specifically, the study set out to evaluate the predictive value of each item on cortisol and, confirming our initial hypothesis, poorer rest and recovery were associated with higher levels of morning cortisol. In addition, significant but weaker, associations between rest and recovery and cortisol levels were found later, during the morning, afternoon and evening. These results clearly reflect the circadian rhythm of cortisol secretion: levels peak in the early morning hours, decrease throughout the day with a nadir at midnight. Apart from confirming a normal diurnal variation of cortisol secretion in a healthy sample, the present results also show that individuals reporting poor rest and recovery have higher cortisol levels in the morning hours (see Fig. 2). This increase does not necessarily reflect an altered circadian rhythm. It is more likely that ratings of poor rest and recovery relate to an increased cortisol output that is particularly pronounced in the morning hours.

As regards the association between salivary cortisol and length of recovery time, the results show that the strength of the associations decreased with the length of recovery time. This is seen in the predictive values of "rested in the morning" and "rested after a weekend" or "medium term long absence". However, no significant associations emerged between self-ratings of recovery after vacation and cortisol; this could be due to the study being based on a healthy group[20] that included only a small number of individuals with an expressed deficiency of recovery after being on vacation. The small variation in recovery after vacation means that the testing of this particular item in the present study can be called into question.

For two items ("rested after a weekend" and "worry about something") an interaction with sex emerged for morning cortisol. While, the women's self-ratings of recovery predicted cortisol level, the men's self-ratings did not. In line with previous research showing that women's stress levels tend to increase after work and during the weekend[1, 14], the present findings may reflect the fact that the weekend—as seen in terms of recovery—is experienced differently by women and men. However, this hypothesis needs to be tested in larger samples.

When it comes to issues of measurement, previous research[27] has shown that the time of measurement of morning cortisol in relation to waking is important for cortisol levels obtained. In the present study, the differences in measurement points and timing of measurements relative to awakening were small and randomly distributed, and were assumed not to have had any marked effect on the results. Also, the self-ratings of rest and recovery and the sampling of saliva were performed on separate occasions. However, the rest and recovery items studied here did not relate to acute changes in cortisol levels. Instead, an individual's ratings of these items described how that this person normally perceived and rated recovery from work. So, the fact that a number of items were predictive of cortisol, despite the fact that self ratings and salivary cortisol samples were collected during different workdays, should be seen as a strength.

Assessment of self-rated recovery from work could be used to prevent future ill health. This study was based on a small group of white-collar workers and this may reduce generalization to other groups of employees. However, studying such a healthy homogenous group reduces the influence of confounding factors. Although the study was of a small group, the statistical power was maximized by the solid design, which involved repeated measurements with each participant providing 12 saliva samples across two days. Yet, the conclusions concerning the causal directions between rest and recovery and cortisol output are, of course, limited due to the cross-sectional study design.

Despite these limitations, we consider that the present results point up a clear relationship between self-ratings of rest and recovery from work and morning cortisol in female and male white-collar workers, thereby extending previous research. However, when the recovery period increases (*i.e.*,"rested after vacation"), the association and predictive value for cortisol disappears, and it may be asked whether it was possible within the frame of this study to adequately validate this item. Furthermore, there were sex differences that indicate a relationship between cortisol output and the items involving recovery after a weekend and worry in women, but not in men.

To sum up, we conclude that—albeit with certain reservations pertaining to homogeneity of the sample—some of the questionnaire items on rest and recovery from work predict physiological recovery in terms of cortisol output.

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