How about work demands, recovery, and health? A neuroendocrine field study during and after work
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Summary

In the Netherlands, four-fifths of society's total costs of work absence and disablement insurance benefits are related to (work-related) psychological and musculoskeletal disorders over the past years. Occupational induced fatigue is thought to play a major role (Chapter 1). One hypothesis on the cause of psychological overload is the vicious circle that begins when, repeatedly, too little opportunity for recovery is given and acute occupationally induced fatigue eventually develops into chronic fatigue. This assumed relationship between work, recovery, and health is described in a way in which occupationally induced fatigue leads to the need for more recovery. This suggests that the short-term effects of insufficient recovery from a working day will lead to long-term effects on health. Reactivity during work and recovery from work is measurable by neuroendocrine parameters, like the excretion of the hormones adrenaline, noradrenaline, and cortisol in urine. Without intermittent recovery, sustained activation develops, resulting in an increase in baseline levels of adrenaline and cortisol. As theoretical background, this thesis included a description of the two neuroendocrine systems that were subject of study - the Sympathetic Adreno Medullary System (SAM system) and the Hypothalamus Pituitary Adrenocortical system (HPA-axis).

In order to differentiate the demands that work-related tasks and activities place upon people, the nature of work was categorised as mental, physical, or a combination of mental and physical demands. The main purposes of this thesis were to determine: 1) The relationship of nature of work and work characteristics to neuroendocrine reactivity during work and recovery from work; and 2) The relationship of neuroendocrine recovery to the subjective need for recovery and health complaints. In order to achieve these goals, a systematic review of the literature and a pilot study (questionnaire study and measurements in the natural work environment) were performed initially. The main study that followed used the same methods as the pilot study. In this main study, mental and physical workers
from a flower auction and from a construction company, mental/physical workers from a municipal ambulance service, and physical worker from a garbage-collecting firm were examined.

Chapter 2 is a systematic review of the literature on studies that focus on neuroendocrine reactivity and recovery after mental, physical, or combined mental/physical tasks. Studies that measured catecholamines (i.e. adrenaline and noradrenaline) and/or cortisol in occupational or sport settings were included. Studies were categorised as those that assessed neuroendocrine reactivity and three time-dependent forms of recovery. In consecutive order, reactivity/micro recovery, meso recovery, meta recovery, and macro recovery were distinguished. Compared to sport studies, there were few occupational studies on this subject. Few studies focussed on the course of neuroendocrine recovery after a specific task. Therefore, it is recommended that future research include the course of neuroendocrine recovery. The chapter ends with an outline of the methods used in the primary studies for this thesis.

In Chapter 3, the relation between the HPA-axis and the SAM system is assessed empirically by performing secondary analyses on data of 115 garbage collectors, who were studied during and after work in their natural work environment. The hypothesis that the morning excretion rate of cortisol could have a facilitating influence on the mean excretion rate of the catecholamines during a working day was tested. The results indicated that, when controlled for the baseline of adrenaline excretion, 46% of the variance in adrenaline excretion during the working day could be explained by cortisol excretion. For noradrenaline, this figure was lower (19%). It was concluded that the pituitary adrenocortical system could have a forward facilitating influence on the adrenomedullary system.

Chapter 4 describes the pilot field and questionnaire study. A study of a random sample of ten male coach drivers performing a shuttle-bus trip in the natural work environment is described in section 4.1. The objective was to evaluate the workload
of shuttle-bus trips by means of neuroendocrine parameters. Urinary excretion of catecholamines and cortisol was assessed during three working days and nights and two consecutive days off. The three working days and the two days off were consecutive too; this is thought to be an essential ingredient for accurately assessing the course of neuroendocrine recovery after the working period of interest. The results revealed occupationally induced reactivity of both catecholamines and cortisol and disturbances in the circadian rhythmicity of the catecholamines. A spillover in the excretion rate of adrenaline was found after the outward journey. The course of recovery in adrenaline excretion after the journey showed a phenomenon that is analogous to overtraining syndrome in sports research. Similar reactions were found in cortisol excretion. The phenomenon has been called 'fatigue debt'.

In chapter 4.2, cross-sectional data from a questionnaire study of 363 Dutch coach drivers in the Netherlands (response rate was 55%) are analysed. The hypothesis tested was whether, apart from job demands and job control, a relation exists between the perceived load at the end of a working day, the subjective need for recovery after a working day, and health complaints. Multiple hierarchical linear regression analyses revealed that need for recovery was related to the level of (psycho) somatic health complaints. It was recommended that future research focus on neuroendocrine reactivity during work, as well as on recovery from work (chapter 4.1). An additional recommendation was to focus on the role of subjective need for recovery in future research on occupationally induced fatigue and as a predictor of health complaints (chapter 4.2).

Chapter 5 describes the results from the main study performed for this thesis. The relation between nature of work and work characteristics, neuroendocrine reactivity and recovery, and health status was tested. The urinary excretion of adrenaline, noradrenaline, and cortisol was examined in fifty-nine male workers between 25 and 55 years of age during five consecutive days; three working days and two days off-work. The workers differed in the nature of their main work demands, i.e.
mental, mental/physical, and physical work. This categorisation was confirmed by a task analysis (observations of tasks and activities) during their work. Personal information and subjective perception of work characteristics, need for recovery, and health status were assessed by self-report through a questionnaire. Differences in neuroendocrine reactivity and recovery between the three groups of workers (chapter 5.1) were examined. A mixed-effects multilevel model was fit for the excretion rates of the three hormones. The model controlled for age, body mass index, baseline, day, and time of day. The work characteristics of job demands, job control, and social relations at work were also included in the model. Differences (main and/or interaction effects) were found between the mental/physical and other groups for all three hormones, indicating overall lower excretion levels in the combined group, as well as poorer recovery in cortisol and adrenaline excretion. The baseline levels of the three hormones were higher in the combined group. For adrenaline and noradrenaline, the mental group differed from the physical group. Job demands was the only work characteristic that contributed significantly in the model (in cortisol excretion).

Multiple linear regression analyses were used to examine whether reactivity, recovery and baseline levels of cortisol and adrenaline were related to perceived need for recovery and health status (chapter 5.2). In addition to the four neuroendocrine measures for adrenaline and cortisol, the possible influence of age, body mass index, and the work characteristics job demands, job control, and the social relations at work was assessed. The model explained 50% of the variation in subjective need for recovery and 54% of the variation in the level of health complaints. In addition to job demands and social relations at work, the only neuroendocrine measure that predicted level of subjective need for recovery was cortisol in the meta-recovery period. Both cortisol reactivity during the working days and meta-recovery after the working days were more strongly related to perceived health status than what was found for adrenaline. However, the baseline level of adrenaline contributed significantly to the level of health complaints, while the cortisol baseline did not. This suggests that workload interventions should focus on
the balance in the nature of tasks within jobs over and above work organisational issues like work-leisure relationship (chapter 5.1). It is also recommended that future research on work-related health disorders include neuroendocrine measures in prospective studies (chapter 5.2).

In the epilogue (Chapter 6), methodological considerations are discussed, a cumulative process model is proposed that integrates the results of this thesis, and the conclusions of this thesis are summarised. The implications of the results of this thesis for future research, policy, and companies are presented in Chapter 7, which emphasises the work-leisure relationship and alterations of tasks.
Multiple linear regression analyses were used to examine whether social support, guideline adherence, and e-mail work overload predicted recovery and baseline levels of cortisol and adrenaline. A need for recovery and health status (Ilmari 5.2) was reported in 2007. In addition to the four neuroendocrine measures for adrenaline and cortisol, the possible influence of skinfold body thickness, index and the work characteristics job demands, job control, and social relations at work was assessed. The model explained 50% of the variation in subjective need for recovery and 54% of the variation in the level of health complaints. In addition to job demands and social relations at work, the only neuroendocrine measure that predicted level of subjective need for recovery was cortisol in the meta recovery period. Both cortisol reactivity during the working day and meta recovery after the working day were more strongly related to perceived health status than what was found for adrenaline. However, the baseline level of adrenaline contributed significantly to the level of health complaints, while the baseline cortisol did not. This suggests that workplace interventions should focus on