"Work and Stress"
Research Group

Examination of individual risk constellations caused by psychological and mental factors at work

Summary of the final report

by

E. Marquard [1],

in collaboration with

Bernhardt, A. [2], Hölzl, R. [2], Möltner, A. [2,3], Weber, V.[1]

1) B A D Gesundheitsfürsorge und Sicherheitstechnik e.V.
(BAD preventive health care and safety engineering)
"Work and Stress" Research Group (Senior researcher: Dr. med. E. Marquard)
2) Partners:
Otto Selz Institute, University of Mannheim,
Laboratory for Clinical Psychology (Senior researcher: Prof. Dr. phil. Dipl. Psych. R. Hölzl)
3) Since 01/2004: University of Heidelberg

Introduction

Psychological, cognitive and emotional stressors are indisputably of critical importance for the health and productivity of the working population, a fact which has prompted research activities and led to the implementation of measures to promote the salutogenesis of the working population.
Of the causes of work-related health problems cited in the absence statistics recorded by health insurance companies and business institutes, “stress” and “consequences of stress” are the factors whose significance has increased most in recent years.
For the purposes of occupational medical care, it is therefore increasingly important to consider the aspects of stress and psychological strain in diagnosis and prevention and to investigate them further.

Stress and its consequences involve a multitude of factors and have a long-term effect on several levels (i. e., from a medical point of view, they affect various target organs). Rather than being linked in the form of a simple cause and effect relationship in terms of a linear forward model, stress and strain are interdependent in numerous respects (interaction model), moderated by individual stress buffers (resources) and coping, and in turn aggravated by aspects of stress arising from the resulting somatic and psychological health problems. Reliable assessment of individual responses to stress and strain in these circumstances requires a multi-level approach, combining examination of work-related stress and individual strain patterns with an evaluation of already existing, individual somato-psychological comorbidity – both carried out with the help of medical, endocrine and psychometric diagnostics.

Based on the results from the pilot stage of the study, the research components and tools were revised for the main stage. Using this inventory, the main research phase aimed to do the following:

- detect differences in the tested variables between the groups by means of a greater sample size and with the help of the improved tools (revised psychometric questionnaire and modified cortisol sampling regimen). A further objective was to confirm or reject trends observed during the pilot stage, e.g. a relation between cortisol and strain levels represented in the scales;
- assess, based on these results, the tools' suitability for detecting and qualifying a critical level of strain to be rated as a “state of stress”;
- examine further the assumed conclusion drawn from the multi-level diagnostic approach for stress and its consequences, i.e. that a stress-related health disorder can only be diagnosed by combined evaluation of all aspects of strain registered by the three research components;
- develop, by means of factor analyses, an abridged screening test for routine examinations, which summarises essential information from the long version; and
- examine further relations between research components by way of combined assessment using the new screening version since the latter is to be used in future research projects.

Methods

As planned during the pilot stage, the methodology based on the three research components

- medical examination,
- psychometric examination by way of a questionnaire and
- laboratory diagnostics (examination of saliva cortisol)

was used for the main stage, too. However, the components and corresponding tools were modified in line with the results of the pilot stage, as described below.

1. Medical examination
   As in the pilot stage, the points examined and the procedure used were based on those in general occupational health examinations, with a particular focus on stress-related symptoms and complaints. An additional questionnaire was developed to complement the standard BAD history and examination record, for the purpose of collecting additional personal data, supplementary information on family history and special information on health problems. Examination of blood values included in the risk profile (serum glucose, blood lipids and CRP) was abandoned because the pilot stage had shown that unusual values were of low significance as far as stress was concerned.

2. Psychometric questionnaire
   For the main stage of research, we used the same COPSOQ version as for the pilot stage. Furthermore, the following scales were adopted without modification: ADS/CES-D[1], Self-Efficacy Scale, STAI-T, WHO-W and MBI.
   In addition, the following scales were incorporated for the main stage:
   - Margraf's A (fear) and D (depression) Screening Scales (1995)
   - the Trait Anger Scale of the State Trait Anger Expression Inventory by Schwenkmezger et. al. (1992) and
   - the scale on stress in private life (developed by BAD).

   The following table shows a summary of the questionnaire used in the examination:

Table 1: Composition of the questionnaire: instruments used

Factor measured	**Instrument / Scale**	**Items**
Work environment characteristics	COPSOQ (medium-sized version) + Coping Scales	102
Affective disorder	ADS/CES-D	15
Depression	WHO-5 Wellbeing Index (WHO-5)	5
	Margraf's D Screening Scale	6
Fear	Margraf's A Screening Scale	6
Anxiety	STAI-T	20
Anger	STAXI-TA	10
Self-efficacy	Generalised Self-Efficacy Scale	10
Burnout	MBI	22
Private stress	Own items	6
Total		**202**

3. Laboratory diagnostics
   The sampling regimen for saliva cortisol was modified due to the results of the pilot stage. We designed a regimen of four samples per day, taken at the following times:
   Sample 1: Immediately after waking up
   Sample 2: 30 minutes after sample 1
   Sample 3: at 4 p.m.
   Sample 4: at 8 p.m.

[1] ADS: Allgemeine Depressionsskala = German version of the Centre for Epidemiological Studies Depression Scale (CES-D)

4. Stress diary
   In order to record factors which could theoretically influence the cortisol level during the three sampling days, we used the Mannheim stress diary to note current psychological state, physical sensations and particular events of the day.

5. Stress analysis
   The workplace analysis checklist according to Gruber and Mierdel, complemented by specific items per profession, was standardised for the different occupational groups. The checklist now contains 25 items.

Samples

All test persons were examined in 2003 and 2004.
As in the pilot stage, contact was established via doctors from BAD, or doctors were instructed in detail to be able to carry out examinations on their own.

In total, 391 persons were examined in the main stage, from the following groups:
- nurses (from hospitals differing in size and medical field),
- teachers (from various primary schools and different types of secondary schools),
- clerks (from municipal and *Laender* social services and foreigners' registration offices),
- hotel service staff (from several big hotels) and
- a random sample (blue collar workers, production workers, doctors, medical assistants and office workers).

The composition of the sample is shown in the following table:

Table 2: Breakdown by occupational group, gender and age group

	N (%)	
Total sample	391 (100)	
Gender		*390 (1 missing)*
Male	122 (31.3)	
Female	268 (68.7)	
Age group		*391*
under 30	68 (17.4)	
30-39	102 (26.1)	
40-49	107 (27.4)	
50 and above	114 (29.1)	
Occupational group		*385 (6 missings)*
Nurses	114 (29.6)	
Teachers	119 (30.9)	
Hotel staff	22 (5.7)	
Clerks	92 (23.9)	
Random sample	38 (9.9)	

Results

1. Medical examination

The incidence of health-related problems is, at 61% of the total sample, slightly lower than the result of the pilot stage. Differentiation shows that sleeping and pain disorders increase with age. With regard to the different occupational groups, health-related problems are significantly more prevalent among teachers and nurses. Whereas nurses suffer most from pain disorders, teachers mostly suffer from sleeping and other disorders (see table 3).

Table 3: Medical anamnesis findings by occupational group

Disorder	Nurses	Teachers	Hotel staff	Clerks	Random sample
	N (%)	N (%)	N (%)	N (%)	N (%)
Endocrine	13 (3.4)	4 (1.0)	- -	5 (1.3)	1 (0.3)
Psychiatric	5 (1.3)	5 (1.3)	- -	2 (0.5)	- -
Neurological	9 (2.4)	9 (2.4)	- -	1 (0.3)	- -
Eating disorder	3 (0.8)	3 (0.8)	- -	2 (0.5)	- -
Sleeping disorder	15 (3.9)	23 (6.0)	3 (0.8)	11 (2.9)	2 (0.5)
(Chronic) Pain syndrome	21 (5.8)	5 (1.4)	1 (0.3)	10 (2.8)	3 (0.8)
Other	9 (2.4)	37 (9.7)	1 (0.3)	19 (5.0)	8 (2.1)

Blood pressure and weight were measured as indicators of physical risk factors.
The mean blood pressure and pulse measurements did not show a deviation from normal values in any of the cases.
The tendency to be overweight generally increases with age (25% in the youngest age group up to 47% in the oldest age group). Men are more overweight than women. Among occupational groups, teachers and test persons from the random sample show a BMI higher than the average of the total sample, perhaps confounding with age.
About half of all test persons (more women than men) show increased risks due to abdominal adiposity (as measured by waist to hip-ratio).

2. Psychometric questionnaire

The self-report part the questionnaire shows an unusual score in the MBI subscale “lack of accomplishment” in all groups. 46% of the total sample show indicators for a tendency to depression.
Two main factors can be extracted from this part of the questionnaire by factor analysis:
Main factor 1: Physical symptoms of stress and anxiety/fear – representative scale: GBB[1].
Main factor 2: Emotional state – representative scale: WHO-5.

In comparison to the Danish reference study, the work-related questionnaire (COPSOQ) shows unusual scores in the following scales: emotional demands, influence at work, span of control at work, job satisfaction and sense of community.
Differentiation by group shows numerous significant differences among each group and also in comparison to the Danish reference study. However, no systemic pattern can be deduced.
After a redundancy analysis of the COPSOQ and the WHO, MBI and self-efficacy scales relating to self-report, 13 CPSOQ scales remain.

[1] GBB = Gießener Beschwerdebogen: Giessen Subjective Complaints List

Dimensional reduction of the total test inventory results in a short inventory (designed as a screening), consisting of:

1. GBB
2. Short version of the questionnaire as illustrated in the following table.

Table 4: Scales used in the short version of the questionnaire

Scale	Number of items
WHO-5	5
Emotional demands	3
Emotion concealment demands	2
Sensorial demands	3
Development opportunities	4
Problem-focused coping	2
Selective coping	2
Resigning coping	2
Meaningfulness of work	3
Transparency	2
Feedback	2
Social relationships	2
Sense of community	3
Insecurity at work	4
Total	**39**

3. Saliva cortisol

Averaged across all test persons, the results for all three sampling days correspond to the typical circadian cortisol profile. The average level when waking up was 15 to 16 nmol/l, which, during the following thirty minutes, rose to an average level of 25 nmol/l (morning increase). The afternoon and evening levels show the expected decrease to levels below the value when waking up (see figure 1).

The men and women in this sample display comparable cortisol levels at all measurement times. A statistically significant difference for measurement time T3 (4 p.m.) is hardly relevant in practice.

Differences between age groups were only observed for the T2 value (30 minutes after waking up ($p<0.05$).

Differences between occupational groups were observed for the T1 value (directly after waking up, $p<0.05$) and the T4 value (8 p.m., $p<0.0001$).
At measurement time T1, the clerks group shows values significantly higher than those of other groups. At measurement time T4, teachers display the significantly lowest values compared to all other groups. Clerks also show values significantly lower than those observed for the hotel staff and random sample groups.

In order to test intra-individual stability of cortisol levels, the corresponding measurement times for the three measurement days were correlated with each other (see table 5).
The two first measurement times of the day, T1 and T2 (directly after waking up and 30 minutes later), show the highest stability in comparison to the later measurement times T 3 and T 4 (4 p.m. and 8 p.m.), and thus the highest share of person-specific variance.
In comparison, measurements at 4 p.m. and 8 p.m. are less stable, which is mainly due to a lower level of statistical spread at these measurement times.

The increase observed in the morning (T2 minus T1) can also be rated as moderately stable.

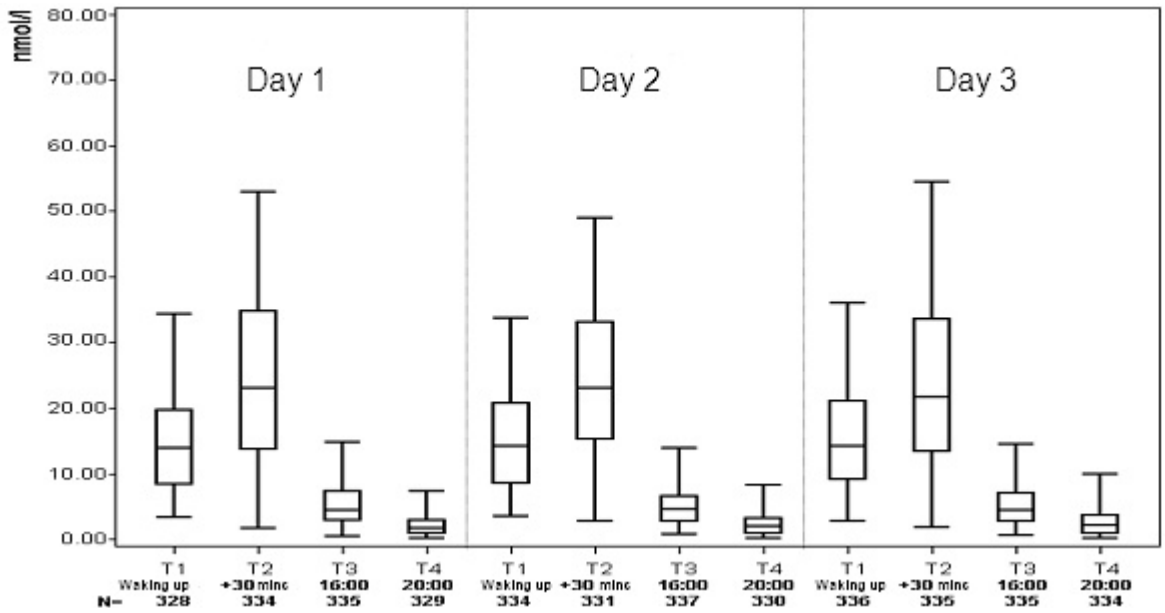

Figure 1: Cortisol profile of the total sample over a three-day period
Box plots with median plus 5th and 95th percentiles

Table 5: Intercorrelations of measured cortisol levels by sampling days. Coefficients for raw data and data with outlier correction by means of winsorisation.

Time of measurement	Day 1 / Day 2	Day 1 / Day 3	Day 2 / Day 3	Pearson Correlation
T1	0.47**	0.37**	0.41**	Raw data
	0.48**	0.40**	0.53**	Winsorised data
T2	0.47**	0.46**	0.45**	Raw data
	0.44**	0.34**	0.32**	Winsorised data
T3	0.26**	0.16**	0.34**	Raw data
	0.24**	0.22**	0.33**	Winsorised data
T4	0.28**	0.15**	0.30**	Raw data
	0.26**	0.31**	0.33**	Winsorised data
T2-T1	0.29**	0.25**	0.39**	Raw data
	0.30**	0.17**	0.24**	Winsorised data

** p<0.01;
Times of measurement: T1 = directly after waking up; T2 = 30 minutes later; T3 = 4 p.m.; T4 = 8 p.m.; T2-T1 = Morning increase (T2 minus T1)

Correlations between cortisol and factors in the screening inventory were low in the total sample and appeared to be mainly coincidental (table 39a).
However, medium to strong correlations were observed within the individual occupational groups, indicating that psychometric symptoms actually are accompanied by cortisol reactions (see table 6, which presents only those factors where there was significant correlation).

Table 6: Correlation of characteristic cortisol levels with factors examined by the screening tool
Medium correlation: Correlation coefficient = 0.2 – 0.4
Strong correlation: Correlation coefficient = 0.4 – 0.6
Level of significance: $p < 0.05$

	Nurses	**Teachers**	**Hotel staff**	**Clerks**	**Random sample**
Exhaustion					Medium
Heart problems		Medium			
Musculoskeletal pain		Medium			Strong
Overall complaints			Strong		Strong
Emotional state	Medium				
Emotional demands			Strong		
Resigning coping			Strong	Medium	
Development opportunities	Medium	Medium		Medium	
Emotional dissonance				Medium	
Sensorial demands	Medium				
Meaningfulness of work		Medium	Strong	Medium	
Social relationships				Medium	Medium
Commitment to the workplace			Strong		

4. Stress analysis

In total, 60 stress analyses were carried out. The score was obtained by adding up all of the individual item values. The score scale starts at a minimum of 25 and ends at a maximum of 100. The results are illustrated in figure 2.

Generally, the teachers group shows a higher stress tendency than the other groups and the random sample group shows a lower stress tendency. This is confirmed by median splitting. However, jobs with relatively high stress levels and jobs with relatively low stress levels can be found in each group.

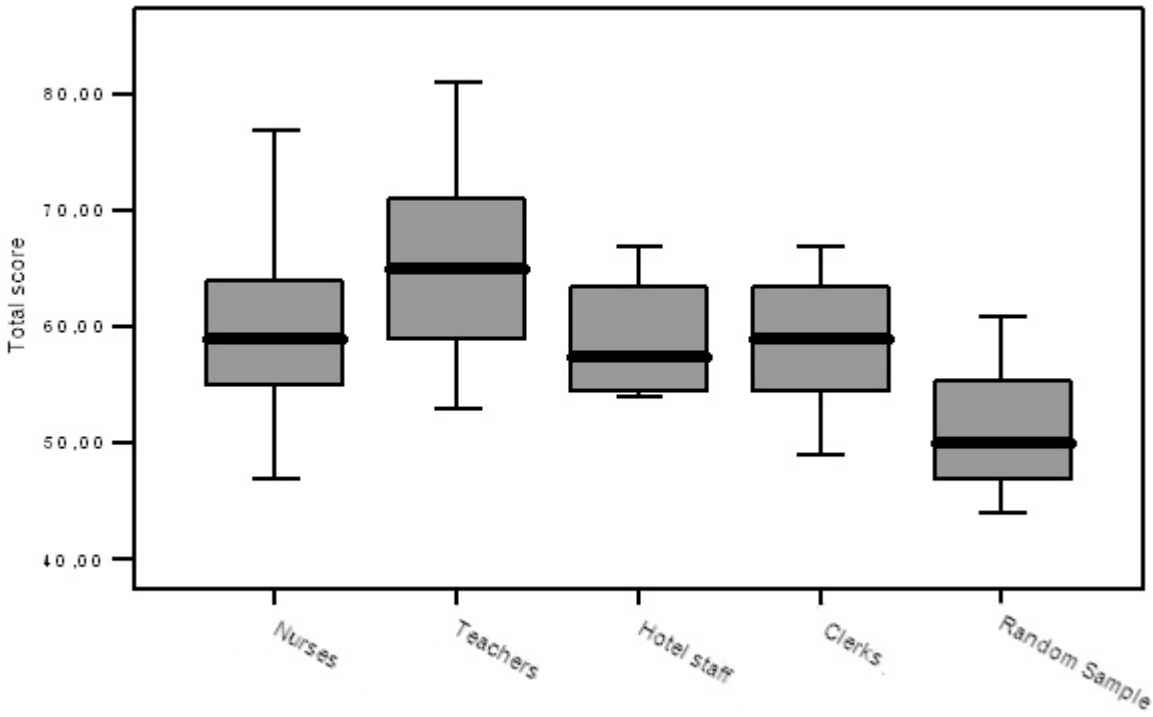

Figure 2: Stress scores per test group. Box plots with median plus 25th and 75th percentiles.

Based on the very general structure of the original tool (with its subscales regarding job content, organisation and special conditions), the characteristics can be structured as follows after factor analysis of the version used in the test:

Component 1: Organisation
Component 2: Work tasks
Component 3: Emotional demands
Component 4: Working conditions
Component 5: Mental demands

There are no correlations between stress analysis and COPSOQ. Either one or both of the tools are invalid, or they both measure different constructs. This question needs to be explored, which may possibly entail clear separation of the stress analysis tool and stress analysis as such, and, as a second step, harmonisation of the two.

Summary and conclusion

In essence, the project's objectives were achieved: the three research tools - medical examination, psychometric tests and the endocrine marker - are practicable in terms of the required time and effort and their acceptability, and they generally provide coherent results and correlations. External validation using data on prospective susceptibility to a disease was not intended within the limited scope of this research.

The psychometric questionnaire and the summarised version devised by dimensional reduction both produce factors that correspond to dimensions of stress described in the literature, and explain a sufficient degree of inter-individual variance.

The good separation of factor loadings furthermore demonstrates that there are no fundamental overlaps. Each individual factor therefore contributes to the achieved results. The factors are thus suitable for providing a general evaluation of work-related mental strain.

Unusual findings, which partly indicated increased mental strain, existed for each group.
The unusual findings for individuals within the groups were distributed unsystematically across the range of characteristics, i.e. there is no typical constellation for an individual of a certain age and occupation. Nevertheless, the existence of an increased level of strain as such can certainly be detected.
The same is true for differences between groups.
The data at hand illustrates that the group of teachers, followed by the clerks group, generally shows most strain. Yet the groups can only be categorised by the number of unusual strain scores, not by specific strain patterns. In its present form, the tool can only be used to identify differential stress profiles of vulnerable individuals, not occupational groups. However, that means that another of the project's objectives has been achieved.

The cortisol protocol tested here is practicable and has proven its value in numerous other studies by other research groups, where it was used in a similar form. Correlations between cortisol and factors in the screening tool were low in the total sample and appeared to be mainly coincidental. Within the groups, however, medium to strong correlations were observed, thus indicating that psychometric (group) characteristics actually are accompanied by cortisol reactions.
The fact that there was no consistent pattern for the entire sample might, for example, be due to heterogeneity of factors and groups. However, the fact that cortisol represents the unspecific neuro-endocrine strain reaction to a critical stress level, in which the type of stress and the resulting mental strain no longer play a role, should be discussed. As a risk-oriented stress diagnosis cannot be concluded in retrospect, neither from stress characteristics nor from mental strain characteristics, a biological marker, such as cortisol, is indispensable to be able to do so.

The aim was to test the stress checklist used here to distinguish jobs with low stress levels from those with high ones. The factor analysis allowed for extracting five factors to characterise work-related psychological stress, but that did not lead to a detection of correlations with research components.

Despite these pioneering results, the project raised several new questions, which cannot be answered within the limited scope of the project but are of importance for further evaluation of stress at the workplace. One main requirement is external validation with the help of a greater sample size in order to solve the problem of the relation between inter-individual and group-specific strain patterns. The question of constructive validity will also have to be revisited with the help of a greater sample size. A further remaining task is the need to test predictive validity by means of an external criterion.

The bibliography can be found in the full version of this report.