Work, stress, and bodily reactions

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Work, stress, and bodily reactions

What is stress?
How to measure stress?
The bodily reaction to workrelated stress?
When is stress unhealthy?
Biological variation
Model

Exposure → Biological response → Effect
Concept of biomarkers

- Stressor
- Acute physiological response
- Long term effects
  - Strain
  - Train

Individual factors
Perceived psykosocial work environment
What is stress?

Example:
Stress is a series of reactions, which may lead to a chronic individual state characterized by a combination of high arousal, aversion and negative expectation about solving the challenge.
What is stress?

**Stress** is your body's way of responding to any kind of demand. It can be caused by both good and bad experiences.

**Stress** is the emotional and physical strain caused by our response to pressure from the outside world.
What is work related stress?
Stressors at the work place

- Chemical exposure
- Job demands, heavy work load
- Job demands, mental demands
- Job control
- Physical work place e.g. noise and temperature
- Physical strain
Reactions to stress

• Cognitive and emotional reactions
• Behavioral reactions/symptoms
• Somatic reactions
• Physiological reactions
Cognitive and emotional reactions

Lack of motivation
Tiredness
Difficulty to remember
Difficulty to concentrate

Anxiety
Irritability
Depression
Low self-worth
Behavioral symptoms

- Lack of appetite
- Sleep problems
- Reservation
- Anger
- Aggression
- Low performance
Behavioral reactions to stress

- Alcohol
- Coffee
- Smoking
- Abuse

Physical activity
Sick leave
Indecisive
Somatic symptoms of stress

- Headache
- Sweating
- Often infections
- Hyperventilation

- Stomach problems
- Loss of weight
- Palpitation/ Pain in the breast
How to measure stress?

Å Questionnaire, e.g.
- Demand/control
- Effort/reward
- COPSOQ
- Perceived stress and energy

Å Observations

Å Bodily reactions to stress (physiological reactions), e.g.
- Cortisol in saliva
- Adrenaline and noradrenaline in urine
How do you feel after a normal workday?

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>Very little</th>
<th>To some degree</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often</th>
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</thead>
<tbody>
<tr>
<td><strong>S:</strong> Refreshed</td>
<td></td>
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<tr>
<td><strong>E:</strong> Active</td>
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<tr>
<td><strong>E:</strong> Energetic</td>
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<tr>
<td><strong>E:</strong> Ineffective</td>
<td></td>
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<tr>
<td><strong>S:</strong> Relaxed</td>
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<tr>
<td><strong>E:</strong> Focused</td>
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</tr>
<tr>
<td><strong>S:</strong> Pressure</td>
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<tr>
<td><strong>E:</strong> Passive</td>
<td></td>
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</tr>
<tr>
<td><strong>S:</strong> Calm</td>
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</table>

Translated from Kjellberg and Iwanowski 1989
Responses from approx. 600 officeworkers

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>Very little</th>
<th>To some degree</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often</th>
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</thead>
<tbody>
<tr>
<td>S: Refreshed</td>
<td>17 %</td>
<td>x</td>
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<tr>
<td>S: Relaxed</td>
<td>5 %</td>
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<td>S: Calm</td>
<td>1.5 %</td>
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</tr>
<tr>
<td>S: Tense</td>
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<td>x</td>
<td></td>
<td></td>
<td></td>
<td>15 %</td>
</tr>
<tr>
<td>S: Stressed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15 %</td>
</tr>
<tr>
<td>S: Pressure</td>
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<td></td>
<td>14 %</td>
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<td>2 %</td>
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<td></td>
<td></td>
<td></td>
<td>x</td>
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<tr>
<td>E: Energetic</td>
<td>3 %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E: Focused</td>
<td>5 %</td>
<td></td>
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<td></td>
<td>x</td>
</tr>
<tr>
<td>E: Sad</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E: Ineffective</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 %</td>
</tr>
<tr>
<td>E: Passive</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Stress scale = 2.3 
Energy scale = 3.0
Stress index

The graph shows the stress index score over time from 00:00 to 00:00 on weekdays and weekends. The y-axis represents the stress index score ranging from 0.0 to 2.5, and the x-axis represents the time from 00:00 to 00:00. Each day (Tuesday to Sunday) has its own line indicating the stress index at different times of the day.
Energy index

![Energy Index Chart]

- **Energy Index Score**
  - Values range from 0.0 to 5.0
  - Data points for each day of the week:
    - Tuesday
    - Wednesday
    - Thursday
    - Friday
    - Saturday
    - Sunday

- **Time**
  - Hours from 00:00 to 24:00

- **Energy Index Chart Details**
  - Data points indicating the energy index at different times of the day for each day.
How the body responds to work-related stress
The sympathetic nervous system

- Adrenaline/noradrenaline increase
- Heart frequency increase
- Blood pressure increase
- More blood to the muscles
- Less blood to the skin
- Low digestion
- Increased brain activity
Biomarkers for catabolic and anabolic metabolism

Catecholamines (adrenaline and noradrenaline)
Cortisol
Glycated hemoglobin ($\text{HbA}_{1c}$)

Testosterone
Growth hormone
Dehydroepiandrosterone (DHEA)
Unwinding after work overload

Total serum cholesterol

Perceived stress

Friedman et al. 1958
Noise

Cortisol (μg/mg creatinine)

- Red: Without hearing protection
- Blue: With hearing protection

Melamed et al., Psychom.Res.1995
Monotonous work

HbA$_{1c}$, Kolesterol, DHEA-S, Testosteron, IgA, Prolaktin, Adrenalin, Noradrenalin, Kortisol

Helbredsundersøgelse

Generelt stress niveau
Oplevet situation

Hansen et al 2003
Job strain and HbA$_{1c}$

Unpublished results

% of total hemoglobin

* p<0.05

low demand/low control  low demand/high control  high demand/low control  high demand/high control

Unpublished results
Outsourcing
Outsourcing

Netterstrøm et al. (2000)
Threat of closing

Norwegian metal workers
(N = approx. 180)

BP (mm Hg)


160
150
140
130
120
110
100
90
80

84 85 86 90 94 96

70
60
50
40
30
20
10
0

16
17
18
19

SBP
Pulse
DBP

Erikssen et al. 1990

BP (mm Hg) (N = approx. 180)
Organisational downsizing and death

7.5 years follow-up study among 22,430 employees in the public sector, who kept their jobs

*Controlled for age, gender, SES og job

When are the physiological reactions unhealthy?
Models for health risk

- Cognitive activation theory
- Allostasis
- Lack of restitution
- Shift of rhythms
- Stress-disequilibrium theory

(Not included)
Bullying and cortisol in saliva

![Graph showing cortisol levels in saliva over time for reference group and bullied individuals.](image-url)
Allostasis
The ability to achieve stability through change.

Allostatic load
The wear and tear that result from chronic overactivity or underactivity of allostatic systems

Successful aging

- Systolic blood pressure (>148 mm Hg)
- Diastolic blood pressure (>83 mm Hg)
- Waist-hip ratio (>0.94)
- Total cholesterol-HDL ratio (>5.9)
- Total HbA\(_{1c}\) (>7.1%)
- Urinary cortisol (>25.7 mg/g creatinine)
- Urinary norepinephrine (>48 mg/g creatinine)
- Urinary epinephrine (>5 mg/g creatinine)
- HDL cholesterol (< 1.45 mmol/L)
- DHEA-S (<2.5 \(\mu\)mol/L)

T.E. Seeman et al. (1997)
Successful aging

T.E. Seeman et al. (1997)
Cortisol and memory

Kirschbaum et al. Life Sci. 1996
Cortisol and memory

Kirschbaum et al. Life Sci. 1996
Cortisol and memory

- Immediate recall bits over days
- Placebo, 40 mg/d, 160 mg/d
Rate of recovery

Exposure
Unwinding after work overload

Reduced reactivity

Stressor
Serum cortisol after stress test

M. Kristensson et al. (1998)
Lack of variability

- High
- Flat
- Normal
Construction workers
Cortisol in saliva during a working day

Significantly higher concentration of saliva cortisol observed in construction workers compared to reference group. No difference was observed between construction workers having long and normal days.

Hansen, 2006
Relative variability in salivary cortisol

<table>
<thead>
<tr>
<th></th>
<th>Construction workers</th>
<th>Reference group</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Long days</td>
<td>Normal days</td>
<td></td>
</tr>
<tr>
<td>CV (%) *</td>
<td>76</td>
<td>99</td>
<td>0.004</td>
</tr>
<tr>
<td>CI (%) #</td>
<td>[65-92]</td>
<td>[91-108]</td>
<td></td>
</tr>
<tr>
<td>CV (%) *</td>
<td>82</td>
<td>72</td>
<td>0.043</td>
</tr>
<tr>
<td>CI (%) #</td>
<td>[64-112]</td>
<td>[57-95]</td>
<td>[91-108]</td>
</tr>
</tbody>
</table>

* Coefficient of variance
# 95% Confidence interval

Hansen, 2006
Conclusion

• Construction workers had higher concentrations of cortisol in saliva during a work day compared to white collar workers.

• Construction workers had lower relative variability in cortisol compared to white collar workers.
Restitution

Demands | Rest | Demands

Catabolic metabolism
Anabolic metabolism
Restitution

- **Catabolic metabolism**
- **Anabolic metabolism**

Diagram showing the relationship between demands, rest, and metabolisms.
Outsourcing

Netterstrøm et al. (2000)
Working hours and blood pressure

Contolled for diabetes, tobacco, physical activity, SES, gender, age (n=24,205, 18-64 år)

Yang et al. 2006
Øresundsbron
Building the bridge between Sweden and Denmark

![Graph showing testosterone levels over days for Pylon workers and Controls.]

Ørbæk et al. 2000
Øresundbron

Exhaustion

% of the day

Dag

Ørbæk et al. 2000

Pylon workers
Track workers
Typical sleep

Gerlach: Søvn, 2003
Hormones respond to sleep

Sleep $\rightarrow$ hormones:
- Growth hormone, prolactin and testosterone $\uparrow$
- Thyroid hormone and adrenaline $\downarrow$
- Cortisol $\uparrow$ during terminal sleep

Hormones $\rightarrow$ sleep:
- CRH reduces sleep quality
- Melatonin stimulates sleep
Stress and sleep

- Stress
  - Need for increased effort
  - Sleep loss
  - Difficulties falling asleep

- Physiological arousal
  - Increased cortisol and adrenaline

Sleep loss leads to increased physiological arousal, which in turn increases cortisol and adrenaline, reducing the need for increased effort, leading to more sleep loss, and making it more difficult to fall asleep.
Sleep problems -> illness

- Increased risk of heart disease
  - Review of 10 studies
  - High quality studies found increased risk of coronary events after adjusting for age and other risk factors
  - The combined risk was 1.7 (range 1.5-3.9)

- Increased risk of diabetes
  - 6599 non-diabetic men at baseline, aged 44.5 ± 4.0 years
  - 281 (4.3%) developed diabetes during follow-up (14.8 years)
  - Men with difficulties falling asleep or regular use of hypnotics had increased risk of 1.52 [95% CI: 1.05-2.20]

Schwarts S et al., J Psychosom Res, 1999
Nilsson PM et al., Diabetes Care, 2004
Sleep and heart disease

A study of 71,617 American nurses followed for 10 years

Psychosocial work and sleep

Increases sleep problems:
• High demands
• Low control
• Keep thinking of work
• Expect difficult workday
• Unsolved conflicts
• Unsolved problems

Decreases sleep problems:
• Social support

Kalimo et al., Stress Med, 2000
Åkerstedt et al., J Psychosom Res 53(1), 2002
Åkerstedt et al., J Psychosom Res 53(3), 2002
Kecklund et al., Biol Psychol, 2004
Shift of rhythms

Fixed shift day

Fixed shift night

Hansen et al., 2006
Garde et al., unpublished data
Biological variation
Biological variation

Physiological
Age, sex, height, health etc.

Genetic
Metabolism & Genotype

Lifestyle
Smoking, alcohol, medicine etc.
Individual factors

Age

Gender

Body mass index
Age

Age

DHEA (nmol/L)

Years of age

19-39  40-49  50-59  >60

Women

Men

AR Genazzani (1998)
Age and BMI

S-DHEA-S (nmol/L)

Hansen et al 2002
Age and smoking

Hansen et al 2002
Testosterone (nmol/L)

Gender

H Olesen et al. (1987)
Individual factors related to lifestyle

- Coffee
- Alcohol
- Smoking
- Medicine
Evening coffee steels your sleep

One cup of coffee contains enough caffeine to half the amount of melatonin

Ingeniøren No 22, Maj 2002, (part of a note from New Scientist)
Urinary adrenaline: Smoking and BMI

Hansen et al. 2001
Genetic factors

Ethnic background:
20% higher levels of S-testosterone in black subjects
% HbA1c lower in Caucasian compared to black subjects
Other Interactions

- Exercise
- Food
- Artificial light
- Wake up
- Circadian rhythm
- Seasonal variation
Circadian variation

Medicinsk Kompendium (1994)
Circadian variation

Plasma cortisol (nmol/L)

Medicinsk Kompendium (1994)
Seasonal variation - epinephrine

Hansen et al 2001
Seasonal variation of DHEAS

Plasma DHEAS (µmol/L)

- Summer
- Winter

Garde et al, 2000
Within and between subject variation

Plasma DHEA-S (μmol/L)

Garde et al, 2000
Within and between subject variation

Blood HbA$_{1c}$ (% of total hemoglobin)

Garde et al, 2000
Questions?

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