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Work Environment and Health Determinants

**Longitudinal, controlled intervention and cross-sectional
studies in public-service broadcasting companies**

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*To
Simon-Fredrik
Frida and
Virve*

ABSTRACT

This thesis focuses on ongoing working life. The overall aim was to identify determinants for work health. Various occupational groups in two public service broadcasting companies in Sweden were included.

Study persons: Participants were from all over the country (n=1961, participation rate 74%) divided in 11 occupational groups. Those on leave more than 6 months were excluded. Mean age was 48 yrs (21-67 yrs), 58% were males. Questionnaire and company register data were collected. Additional matched reference data from Statistics Sweden was captured. In a substudy the data collection comprised of repeated blood sampling, physical measures, and questionnaires at three occasions during 12 months (n=121, participation 95%). Another substudy was based on questionnaire responses and participants' web-documentation of stress programme utilization (n=243, participation 96% and in follow-up 83%).

Methods: A comparison was performed between persons with no sick-leave (well-listed) and with any sick-leave (<6 months, mean 25 days) with regard to work environment and organisation, health, sociodemography, life-style, and occupation. The same factors were compared to perceived work place aesthetics. Stress biomarkers' relations to pain in neck-shoulder-back were analysed longitudinally during 12 months, and cross-sectionally. In a randomized controlled intervention follow-up during 12 months, the impact of a health promoting web-based stress-intervention programme on musculoskeletal pain and its relation to stress was analysed.

Results: Individuals in working life with a high level of regenerative (anabolic) activity and a low level of degenerative (catabolic) activity were less likely to have pain than other subjects. Longitudinally, decreased anabolic activity was associated with increasing pain and vice versa (levels of NPY, albumin, GH and HDL). Low level of DHEA-S predicted pain 12 months later.

A web-based health and stress-management programme did not decrease neck-shoulder-back pain and the perceived pain-relatedness to stress. Broader and multifactorial intervention methods might be needed.

In the whole study population, 53% were well-listed (no sick day). The gender and age dependence was pronounced; more males and older persons being well-listed. As opposed to some earlier reports, sociodemographic conditions and life-style factors were weak or showed no difference between the well-listed and not well-listed participants. Neither did psychologically demanding work and stress outside work show any differences. Strong health determinants were on the one hand *less*: ill-health work presenteeism, work-related pain, negative work stress, sleep disturbances, need for ergonomic improvements, monotonous work, bent and twisted work positions, disturbing noise, and on the other hand *more*: perceived good health, support from superior, influence on work performance, and working irregular hours including evenings. Physical training showed a weak association to well-listing when weekly or more frequent. Differences between occupations were shown. - As compared to the matched national reference sample, the study population reported more sleep disturbances, shoulder pain, anxiety, disturbing noise, demanding work positions and psychologically demanding work. Nevertheless, the sick-absenteeism was lower than the national average at the same time period.

The perceived need for *aesthetic* improvements was associated to negative work stress, problems at work, psychologically demanding work, neck-shoulder-back pain, sleep disturbances, and age (lower). Gender and physical training had no impact, whereas occupational status did. 20% reported no need and 46% reported a high need for improvements. The corresponding figures for ergonomic needs were 20% and 34% respectively. The response distributions of aesthetic versus ergonomic needs were significantly different.

Conclusion: The results identify work-related health determinants and salutogenic predictors, from stress biomarkers to work environment and organisation. The findings may be employed in future studies and influence future work health promotion and intervention.

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SAMMANFATTNING

Avhandlingens övergripande mål var att identifiera det som utmärker hälsa i arbetslivet. Fyra delstudier utfördes på personal i två "public service" media företag i Sverige.

Undersökningspersoner: Deltagare från hela landet omfattades (n=1961, deltagande 74%), uppdelade i 11 yrkesfunktioner. De som hade frånvaro mer än sex mån före studien exkluderades. Medelåldern var 48 år (21-67 år), 58% var män. Enkätvar och företagens registerdata studerades. Därtill ingick som referensgrupp en tids-, köns- och åldersmatchad tjänstemannapopulation från Statistiska Centralbyråns befolkningsundersökningar. I en delstudie bestod datainsamlingen av upprepade blodprover, fysiska mätningar och enkäter vid tre tillfällen under 12 månader (n=121, deltagande 95%). En annan delstudie baserade sig på enkätvar och rapport från användandet av ett web-baserat stress- och hälsoprogram (n=243, deltagande 96% och i uppföljning 83%).

Metoder: En jämförelse gjordes mellan personer utan sjukfrånvaro och personer med sjukfrånvaro (< 6 mån, genomsnitt 25 dgr) med avseende på: Arbetsmiljö och -organisation, hälsa, socioekonomi, livsstil och yrkesfunktion. Motsvarande faktorer jämfördes även med upplevt behov av förbättringar på arbetsplatsen estetiskt sett. I en av delstudierna analyserades stressbiomarkörers korrelation med besvär i nacke-skuldror-rygg longitudinellt under 12 mån samt i tvärsnittsanalys. I en kontrollerad randomiserad interventionsstudie av ett web-baserat stress- och hälsoprogram studerades effekter på smärta/besvär och besvärens relation till stress.

Resultat: Personer i arbetslivet med en hög nivå av anabol hormonaktivitet (uppbyggande) och låg nivå av katabol aktivitet (nedbrytande) visade sig ha lägre risk att ha smärta/besvär i nacke-skuldror-rygg än övriga. Långitudinellt var minskad anabol aktivitet relaterad till ökade besvär och vice versa (nivåer av NPY, albumin, GH och HDL). Låg nivå av DHEA-S predikterade smärta 12 månader senare.

Den web-baserade stress- och hälsointerventionen påverkade inte besvär i nacke-skuldror-rygg och inte heller det upplevda sambandet mellan dessa besvär och stress. Andra och bredare interventionsmetoder synes behövas.

I hela studiegruppen hade 53% ingen sjukfrånvaro. Köns- och ålderskillnaden var uttalad, med fler män och fler äldre utan sjukfrånvaro. Till skillnad från andra studier av företrädesvis långtidssjukskrivna, visade socioekonomiska faktorer svaga eller inga skillnader mellan dem med och utan sjukfrånvaro. Inte heller visade psykiskt ansträngande arbete eller stress utanför arbetet skillnader. Starkt utmärkande för dem utan sjukfrånvaro var å ena sidan *mindre*: sjuknärvaro, arbetsrelaterad smärta/besvär, negativ arbetsstress, sömnstörningar, behov av ergonomiska förbättringar, monotont arbete, böjda och vridna arbetsställningar, störande ljud/buller och å andra sidan *mer*: upplevd god hälsa, chefsstöd, inflytande på arbetets utförande och arbete på oregelbundna tider inklusive kväll/helg. Fysisk träning var svagt utmärkande för dem utan sjukfrånvaro. Det fanns skillnader i resultat mellan yrkesfunktioner.

Jämfört med den matchade referensgruppen ur nationell statistik rapporterade studiepopulationen mer sömnbesvär, ont i skuldror, oro, störande buller, påfrestande arbetsställningar och psykiskt krävande arbete. Likväl var sjukfrånvaron väsentligt lägre än landets genomsnitt för samma period.

Upplevda behov av estetiska förbättringar var relaterade till negativ arbetsstress, problem på arbetet, psykiskt ansträngande arbete, nacke-skulder-rygg besvär, sömnstörningar och ålder (yngre) och yrkesfunktion - däremot inte till kön eller fysisk träning. 20% rapporterade 'inga behov' och 46 % 'stora behov' av förbättringar. Motsvarande siffror för ergonomi var 20% respektive 34%. Svarens spridning av estetiska respektive ergonomiska behov skilde sig signifikant.

Konklusion: Resultaten indikerar arbetsrelaterade hälsodeterminanter och salutogena prediktorer, från stressbiomarkörer till arbetsmiljö; fynd som kan användas i framtida studier och påverka hälsopromotion och intervention framöver.

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It is not stress that kills us; it is our reaction to it. Adopting the right attitude can convert a negative stress into a positive one.
Hans Selye 1907-1982

Yes, there is goal and meaning in our path
but it's the way that is the labour's worth.
Karin Boye 1900-1941

Nog finns det mål och mening i vår färd
men det är vägen som är mödan värd.
(In Swedish) *Karin Boye 1900-1941*

List of publications

This Thesis is based on the following papers, which will be referred to by their Roman numerals:

- I Elisabet Schell, Tores Theorell, Bo Nilsson, Helena Saraste
Occupational health characteristics with regard to work organisation
and environment, stress, health and sociodemographic factors.
Comparison between well-listed and not well-listed professional employees.
Submitted 2008
- II Elisabet Schell, Tores Theorell, Dan Hasson, Arnetz B, Helena Saraste.
Stress biomarkers' associations to pain in the neck, shoulder and back in
healthy media workers. 12-month prospective follow-up.
Published: European Spine Journal 2008;17:393-405
DOI 10.1007/s00586-007-0554-0 (2007)
- III Elisabet Schell, Tores Theorell, Dan Hasson, Bengt Arnetz, Helena Saraste.
Impact of a Web-Based Stress Management and Health Promotion
Program on Neck-Shoulder-Back Pain in Knowledge Workers? 12 Month
Prospective Controlled Follow-Up.
Published: Journal of Occupational Environmental Medicine. 2008;50:667-676
- .
- IV Elisabet Schell, Tores Theorell, Helena Saraste
Workplace aesthetics: Impact of environments upon employee health?
Accepted 2008

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European Spine Journal (Eur Spine J)

Paper III has been reprinted by permission from:
Journal of Occupational and Environmental Medicine (J Occup Environ Med.; JOEM)

Abbreviations

B-HbA1C	glycosylated haemoglobin
BMI	Body Mass Index
CI	confidence interval
CNS	central nervous system
Cortisol	stress-hormone produced in the adrenal cortex
DHEA-S	dehydroepiandrosterone sulphate (anabolic precursor of sex hormones)
HPA	hypothalamic-pituitary-adrenocortical (part of stress-hormone system)
MSP	musculoskeletal pain
NPY	neuropeptide Y
OR	Odds Ratio
P-BNP	brain natriuretic peptide
RCT	Randomized Controlled Trial
RR	Relative Risk
S-CRP	(serum) high sensitive c-reactive protein
SD	standard deviation
SE or SEM	standard error of mean
S-GH	(serum) growth hormone
S-HDL	(serum) high density lipoprotein (“good cholesterol”)
SRH	self rated health
VAS	visual analogue scale
VDU	video display unit
WHO	World Health Organisation
vs	versus

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Explanations

Allostasis	The body systems' ability to compensate for changes, stress regulation adapted to long lasting constant arousal (e.g. circulation-system, hormones, metabolism and immune protective system)
Homeostasis	The mechanisms which act to keep the body organs and cell surroundings as stable as possible. The body's respond to threat e.g. "flight-or-fight"-reactions.
Long term sick-listing	More than half a year of sick-listing - as used in this thesis
Salutogenesis	From Latin salus = health; and Greek genesis = origin i.g. sources of health
Professional employee	Employee with 'high or low' professional skill e.g. white collar workers and other employees who are educated or otherwise experienced workers (tjänsteman in Swedish).
Well-listed	No day of sick-listing - as used in this thesis. It does not exclude sickness presenteeism at work.
Not well-listed	Sick-listing less than half a year - as used in this thesis
Work health	Part of work ability which is due to health with or without sick-listing prevalence. 'Being well and feeling fit for work'
Work-room employees	Studio and work room professionals (mask, costume-makers, tailors and assistants, wigmakers, carpenters, painters etc)

INTRODUCTION

1. Background

During the 1990s it was predicted that psychosomatic syndromes in the work force will increase in the foreseeable future due to rapid changes of working life¹². Work and stress related problems had been documented earlier, including the role of gender in stress symptoms^{76, 96, 112, 113, 114, 120, 161, 171, 172}. The relationships between work and back pain were studied^{27,120, 139}. Studies on rehabilitation were numerous^{115, 139, 176}.

Work environment research is turning to more complex patterns of exposures and interactions^{73,75,79,114,183,185}. Demands for employee adaptability are increasing¹⁵. The work demand control model by Karasek and Theorell⁹⁵ remains in focus. The ongoing changes in occupational conditions generate a continuous need to study their possible impact on health and work ability^{3, 10, 18}. In working life, the reaction of perceived stress and biomarker changes to downsizing were presented by Grossi G et al^{61, 62} and Hertting A et al⁷⁵.

For many reasons, such as, the complexity of work related health problems it is of interest to develop screening models to identify health predicting determinants that can be expressed in quantifiable and comparable units. One example could be blood testing e.g. physiological stress biomarkers, another pre-validated questionnaires. Such testing should apply to different organisational structures and professions^{53,57, 68, 98, 101, 113, 117, 118, 144, 186, 187}.

Rapid technical development and changes in legislation have contributed to decreasing physical load in most occupations¹⁹³ in the Western world. This resulted in a decreasing occurrence of occupational low back pain whereas the prevalence of neck-shoulder pain has remained high⁸⁰, still accompanied by low back pain as a serious health problem^{55, 67, 84, 111, 171,164, 183,193} though. Neck-shoulder pain in particular, is considered to be related to stress^{11,23,37, 109,110, 113,114,121,126,180} besides that monotonous work tasks and heavy loading is considered to be risk factors for work related pain including neck and shoulder^{75,78,81,84,85, 97,101, 117,139,181}.

The increasing occurrence of neck-shoulder pain as an occupational problem, is considered to be associated with increasingly IT-based life style, monotonous work, frequent work reorganisation, work strain and other life-style factors^{12, 193}.

National stress-related sick-listing increased gradually during the 1990s^{164,171}. Thereafter work health research topics increasingly have tended to be dominated by issues, such as work environment, organisation, psychological work demands, stress reactions, personality, life-style and musculoskeletal pain (MSP)^{73,79,109,118,119,121,183,197,200,202,203}. A relation of some stress biomarkers to acute back-pain was proposed by Hasselhorn et al⁶⁹ in 2001 and Hasson et al⁷⁰ showed alterations in stress biomarkers directly after a stress intervention in working life in 2005.

However, it is at present not clear whether the changes over time in work related sick-leave reflect true sickness^{15,163,164}. Swedish legislation for sick-leave compensation has changed several times during the past few decades¹⁷¹, and an increase in sick-leave during the 1990s was seen followed by a decrease the past five years^{164,171}. Compensation systems vary widely internationally, which fact also complicates comparisons.

Several recent Nordic population studies of work related sickness absenteeism point at the role of physical and psychological occupational strain^{110, 117,126,187,197,198}.

In occupations involving high level of cognitive stress such as teaching¹⁵, stress-related disorders are considered to dominate as causes of long-term sick-leave. Yet MSP problems occur in the same groups¹⁷¹. In line with this it is of interest to study a large working population in public service broadcasting companies with regard to health, work environment and the relationship of stress biomarkers to neck-shoulder-back pain.

The research presented in this thesis focuses on white collar workers and professional employees e.g. educated or otherwise experienced and skilled workers.

The overall purpose was to find possible health determinants and predictors, which knowledge may contribute to health promotion and sickness prevention in working populations.

2. Sick-leave, cost aspects and gender perspective

Economical aspects for society, employers and individuals are usually analysed in terms of 'health economics'^{25,31,63,114,162,167}. Employers' costs for non-optimal work environments and sick-absenteeism were highlighted during the 1990s by Liukkonen Paula and Johansson Ulf at Stockholm and Uppsala Universities, respectively. Employers' costs were described in terms of less productivity from employees who do not feel well, sick-leave compensation, work delayed by sickness-absenteeism, replacement or stand-in recruitment with associated work introduction, and the recruitment of new employees. Society's costs for sick-leave compensation¹⁷¹ were accelerating. There are rehabilitation costs with resources already insufficient, and costs for treatment and drugs²⁵. The literature review "Prescribed sick leave – causes, consequences and physician's certification practice" in 2003³ confirmed the predomination of sick-leave due to MSP followed by stress-related disorders and cardiovascular diseases. Leijon O¹¹⁰ and National statistics¹⁷¹ reported the female predominance in sick-leave and in pain-related symptoms.

Consequences of sickness presenteeism - "sick but still at work" - were analysed by Aronsson G et al in 2000¹⁶. They found that persons with more sickness presenteeism also had more sick-leave than others. Job-productivity was affected by sickness presenteeism.

Lindberg et al concluded in 2005^{117,118} that on one hand promotion factors and on the other hand preventive factors for work ability were: physical conditions, clear work tasks, positive feed back for promotion; and recuperation, organizational and psychosocial factors, respectively for prevention.

3. Health promotion, prevention and rehabilitation - working life

On the the 6th WHO (World Health Organisation) conference 2005 on **health promotion** in Bangkok it was declared that the global context for health promotion had changed - now high lightening that "the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human". The earlier Ottawa context was to enable people to "increase control over and to improve their health¹⁹¹".

The Ottawa Charter for Health promotion in 1986 had defined that "health promotion is the science and art of helping people to change their lifestyle to move toward a state of optimal

health” Optimal health was defined as a balance of physical, emotional, social, spiritual, and intellectual health. Lifestyle changes can be facilitated through a combination of efforts to enhance awareness, change behaviour and create environments that support good health practices. Of these, supportive environments probably will have the greatest impact on producing lasting changes. The objective of health promotion is “to encourage and support health” as published by O’Donnell 1989 ”¹⁴⁵.

The concept of health promotion was discussed to be widened to “**workplace health promotion** (WHP)”. Approaches to WHP encompass the design of healthy working conditions and the in-corporation of health needs into corporate philosophy and management. An example of this is the Luxemburg Declaration on Work Place Health Promotion in the European Union^{48,50}. This was adopted by the members of the European Network for Health Promotion 1997 and defines WHP as follows:

“Workplace Health Promotion is the combined efforts of employers, employees and society to improve the health and well-being of people at work. This can be achieved through a combination of:

- *improving the work organisation and the working environment*
- *promoting active participation*
- *encouraging personal development ”*

Prevention means to stop or impede a development when a risk for a disorder is known or a disorder is already involved. According to Kaplansky et al 1998⁹⁴ definitions could be broken down as follows: a) primary prevention directed to the healthy person in order to prevent the occurrence of disorder, b) secondary prevention attempting to reduce the prevalence of a disorder through early detection and treatment (i.g. early rehabilitation), c) tertiary prevention, involving strategies that minimise the consequences of the disorder by reducing chronic impairment and disability (i.g. rehabilitation).

In rehabilitation (tertiary prevention) multimodal treatment programs regarding both stress and musculoskeletal pain (MSP) which are common causes of poor health, sick-leave and lower quality of life, are in use^{17,151}. Positive impact is shown in multimodal rehabilitation programs with cognitive therapy, physical therapy including relaxation programs and activity^{17, 167}. Concepts of stress management comprise a large range of interventions for example coping strategies, education, practical workplace training, and different behavioural techniques¹⁵¹. Anxiety and depression are large areas where different stress management interventions, including applied behavioural training as well as musculoskeletal relaxation training, have frequently been used^{17,32}. Evaluations studies of the effects of stress management on musculoskeletal symptoms have been reported^{192,194,195}.

Stress management conducted as muscular relaxation training is a common mode of treatment of different kinds of pain symptoms within secondary and tertiary prevention¹⁵⁰. Although the relaxation techniques in different studies vary; most studies report a decrease in the measured symptoms directly after the termination of the intervention⁷¹ whereas longitudinal follow-ups are lacking or are showing weak remaining effects. Relaxation training in combination with physical therapy or behavioural therapy seemed in some of the reports to be more beneficial on the studied symptoms than relaxation training alone⁸¹. Self-help stress interventions relates to approaches where individuals learn how to help themselves. Frequently books are used in these studies, but there are various modes of self-help, nowadays also including interactive web-sites and tape/CD-recordings.

Scientific publications on longitudinal results from working life interventions with regard to stress, and musculoskeletal symptoms are fairly rare. Thorough experiments and well performed evaluations have been published, however^{70,81,194}.

Stress management in these studies also seemed to have had an impact on stress biomarkers^{70,150,194} for example decreased salivary cortisol levels and increased levels of anabolic hormones as well as significantly increased self reported levels of relaxation. The studies provide evidence for possibilities for improvements as well as obstacles in achieving positive results. Bernin et al 2001²² found in a study of managers that good social support at work was health-promoting, at least with regard to some biological stress biomarkers. A web-based stress intervention programme for IT workers showed beneficial results on stress biomarkers and other stress factors directly after an intervention⁷⁰, but not 12 months later. An 18-month longitudinal study⁸¹ of women in health-care occupations concluded that a multifactor approach may be of importance in the early prevention of sick-leave due to neck, shoulder or back pain. These studies indicate carefully targeted approaches in working-life health intervention, economic aspects included^{22, 70,81,194}.

Work related neck, shoulder and back pain are considered to be multi-factorial^{12, 49,90,101,139,153,173} and the prevalence is high, white collar workers included^{181,183}.

Perceived stress as a risk factor for musculoskeletal disorders contribute to that it may be hypothesized that stress management with its focus on decreasing sources of perceived stress and strengthening empowerment will have a positive impact on neck-shoulder-back pain⁸¹. Considering that MSP and stress are closely connected^{29,32,81,180,193} the question arises - whether the self reported prevalence and intensity of neck-shoulder-back pain, not yet classified as long lasting/chronic, can decrease after practising a web based stress intervention program. In the prevention of occupational MSP and stress it is desirable to find cost effective methods available for various occupational groups. Evaluations from more longitudinal prevention programmes are needed³¹.

4. Stress

The originator of the biological stress definition was Hans Selye (1907-1982). The phenomenon he called "stress" in 1936 could be anything from prolonged food deprivation to the injection of a foreign substance into the body, to a good muscular workout^{160,161}. By "stress" he did not mean only nervous stress, but "the nonspecific response of the body to any demand". Selye did several studies on the non-specific part of the response of the organism to stressors. While Selye did not recognize all of the many aspects of glucocorticoids, he was aware of their role in this response. Some commentators considered him the first to demonstrate the existence of stress. According to Selye's terminology a stressor or stimulus can be described as an internal or external physical or mental load, which constitutes a potential threat to an individual's homeostasis.

Goldstein and McEwen's stress definition in 2002⁵⁸ was: "stress is a condition where expectations, whether genetically programmed, established by prior learning or deduced by circumstances, do not match the current or anticipated perceptions of internal and external environment, and the discrepancy between what is observed or sensed and what is expected or programmed elicits patterned compensatory responses".

The stress reaction can consequently be behavioural or physiological. The behavioural reactions might result in destructive life patterns contributing to the metabolic syndrome according to Bjorntorp 2001²⁴, which is a growing health hazard in the Western world¹⁷⁰. The psychological reaction may result in increased blood pressure and heart rate, as well as increased muscle tension. Perceived stress may contribute to increased health risks as for example increased risk taking and accidents according to Lundberg U in 1996.

According to European Union 2005⁵⁰ “stress is the second most reported work-related health problem, affecting 22% of workers from the EU 27 countries. They concluded: “the changing world of work is making increased demands on workers, through downsizing and outsourcing, the greater need for flexibility in terms of function and skills, increasing use of temporary contracts, increased job insecurity and work intensification (higher workload and more pressure), and poor work-life balance”.

5. Stress physiology, HPA-axis and biomarkers

All stressors, internal or external, activate the biological stress response which put into play the central nervous system (CNS), the endocrine and immune system, or by the sympathetic nervous system (SAM)⁵⁶.

The hypothalamus-pituitary-adrenocortical axis (HPA-axis) and the autonomic nervous system (ANS) are responsible for mediating information regarding stressful situations to different organs. The information passes via nerve impulses or blood circulation, changing the metabolism in the organs in order to help the individual to handle the aroused situation described^{47, 56}.

During stress the internal secretion of corticotrophin releasing hormone (CRH) increases, further stimulating the pituitary gland to increase internal secretion of adrenocorticotrophic hormone (ACTH). This is transported to the adrenal cortex, which in turn releases cortisol. Stress also has an impact on the hypothalamus-pituitary-gonadal system axis (HPG) with a reduced internal secretion of gonodotrophic releasing hormone (gnRH), affecting both female and male sexual functions^{47, 56}.

There are several stress biomarkers influenced by internal and external impact. The autonomic nervous system (ANS) is responsible for mediating information regarding stressful situations to different organs. The CRH also affects the sympathetic nervous system activity, resulting in an increase in catecholamines. Stress also has an impact on HPG-axis with a reduced internal secretion of gnRH affecting both female and male sexual function as well as regenerative and anabolic reparative functions.

Some of the stress bio markers interact and some of them could be either beneficial or damaging to health and well-being depending on the circumstances, as for example cortisol and neuropeptide Y (NPY).

A number of well-known stress biomarkers could cautiously be classified in groups^{56,70} as follows:

- a) cardiovascular system and life style
- b) catabolic-stress-related hypothalamic-adrenal-axis (HPA)
- c) anabolic-recovery-related
- d) immune markers and peptides

a) Brain natriuretic peptide, **BNP**, was described by Struthers et al¹⁶⁵ to be “a simple new test to identify coronary artery disease” in males. Elevated body mass index, **BMI**, values and high waist-hip are well known risk factors for circulation system injuries and diseases, such as diabetes¹⁷⁰, and has been shown to be related to musculoskeletal pain^{51,93,56}. **Insuline** decreases the concentration of glucose in blood and is used in diabetes control and as a medical treatment for those patients. It increases the glucose uptake in the muscular system which is responsible for the main part of the hypoglycemic effect. Glucated haemoglobin, **B-HbA_{1c}**, concentration reflects mean blood glucose concentration and is used in diabetes control. Increased concentrations are shown to be related to retinopathy, microalbuminuria and neuropathy. Within the fraction of low density lipoprotein, **LDL**, the main part, 60-70%, of cholesterol is transported in the vessels, whereas 25-35% is transported within high density lipoprotein, **HDL**⁵⁶.

b) Decreased **albumin**, **prolactin**, **ACTH**, **S-cortisol** and saliva cortisol concentration is seen in inflammatory and catabolic conditions⁵⁶. **Albumin** concentration level is known as a mirror of general anabolic levels as for example testosterone, estradiol, S-DHEAS and growth hormone. **Fibrinogen**, an acute phase protein⁵⁶, is a sensitive indicator of inflammation, which can be a complement to CRP.

c) **ACTH and cortisol** levels are inter-dependent. They respond to stress⁵⁶ and vary throughout the day. The ACTH is normally highest in the early morning, though it can vary rapidly within a few minutes, and it is at its lowest level in the evening. Cortisol excretion is normally high in the morning and increases during the early morning period, and is reduced in the afternoon and the evening. It is known from previous studies^{56,70} that sex hormones might be sensitive to stress exposure. The anabolic hormone DHEA-S, precursor of both male and female sex hormones, is known to be related to stress and psychiatric disorders, insulin sensitivity, immunological and cardiovascular disorders according to Kroboth et al¹⁰² and Westerlund et al¹⁹⁰. Hasson et al⁷⁰ found a possible association between the effects of a web based stress intervention and DHEA-S. The sex hormones testosterone and Estradiol are closely connected or dependent on S-DHEAS⁵⁶. Growth hormone, **GH**, has a circadian variation. The excretion increases in recovery and relaxation processes, and decreases with lack of recovery⁵⁶.

e) High sensitive c-reactive protein, **CRP**, is a well documented and sensitive marker of inflammation and/or any tissue injury⁵⁶. Neuropeptide-Y, **NPY**, was shown to promote sleep and inhibit ACTH and cortisol release in young men, and influence HPA-axis activity, according to Antonijevic et al⁹. Anderberg⁷ found increased NPY levels in patients with fibromyalgia and long lasting pain. She concluded that long lasting pain may activate NPY anxiolytic and sedative effects. NPY is clearly a marker that can be influenced in both directions by pain.

Endothelin is known as one of the most powerful vasoconstrictor substances. In mice with neuropathic pain after chronic constriction injury of the sciatic nerve Klass et al¹⁰⁰ found that endothelin was a mediator of pain in general. They

suggest that their results motivate studies of endothelin as a potential basis for novel therapy for neuropathic pain. Nattero et al 1996¹⁴¹ showed that plasma endothelin-1 concentrations decreased during migraine attacks.

To our knowledge there are studies confirming some stress biomarkers' relation to chronic pain diseases and to acute pain as mentioned^{7,59,69}, whereas studies on stress biomarkers' relation to mild or moderate pain are to date unknown.

The intention within this thesis was to study stress biomarkers relation to mild or moderate pain.

6. Psychosocial stressors and work environmental factors

Two theoretical models of work related psychosocial factors have been in focus for several years. One is the Demand-Control model according to Karasek and Theorell 1990⁹⁵ which states that among many other things that a high level of decision latitude may protect the individual against adverse effects of high demands. Another model is the Effort-Reward model according to Siegrist 1996¹⁶³. Its focus is the association between perceived effort put into one's job and reward in terms of appreciation, salary and career opportunities. If the effort is bigger than the perceived reward this might lead to long lasting stress reactions.

Psychosocial and psychological stress has been defined as an interaction process between environmental demands and the individual's ability to meet those demands according to Lazarus and Folkman 1984¹⁰⁶. A psychosocial stressors can be social, economic, or caused by organizational circumstances at work according to Melin et al¹³⁴ and Lundberg et al 2002¹²⁵. Lundberg pointed out that perceived stress may contribute to increased health risks as for example increased risk taking. According to Lazarus in 2000¹⁰⁵ coping ability and social support are important factors to take into consideration when analysing the effects of stress.

Several models have been presented to explain the interrelationships between psychosocial factors, personal resources (such as cognitive resources, coping style, social support, genetic characteristics, prior experience, and psychological responses) and ultimate health and well-being. Kagan and Levi in 1974⁹² formulated a theoretical model, which was further developed to apply to the work place by Carayon and Sainfort in 1999¹⁹³. The latter links the interactions between technology, organization, task, and environment to human functions and musculoskeletal symptoms. It is described as a framework for examining job stress, comprising five elements namely: task, environment, organisation, technology, and individual characteristics. The task element: 1) workload factors such as quantitative and qualitative under-load and over-load; 2) environmental element, both physical and psychological factors, such as social support and skill-utilisation 3) organizational element, the context in which the work is done i.e. career consideration, over- or under-promotion, lack of job security, work schedule, overtime etc 4) technological aspect: physical and mental requirements, software usability, and system support 5) individual element: personality, gender, genetics.

Psychosocial work environment could be concluded to be the "interactions between social work environment factors as well as organisational factors and individuals at workplace" which includes the social climate, organisational issues, responsibility, and demands as well as decision latitude regarding one's job which may have an impact on the individual's health and well-being at work.

The models mentioned demonstrate the complexity of the interaction between environmental factors, individual characteristics, work environmental factors and possible ill-health outcome.

Factors from these models are included in the present thesis.

7. Physical work environment including work place aesthetics

With a rapid move till today the physical work environment factors which are correlated with employees' health at work could be presented as work posture, work movements, work load, monotonous work, climate, and not the least - the interface man-machine as forecoming in the rapidly increasing numerous different kinds of computer and IT based work conditions.

The continuous need to examine physical work conditions that may contribute to ill-health and poor work ability^{3, 117, 119, 122, 128, 184, 197} has rendered to several population studies of work-related-sickness absenteeism. Since work health related advantages and problems vary between occupational groups, companies and organisational structures, analyses of "healthy work" factors and improvement needs in diverse workforces, are required^{53,57,68,98,101,125,134,144, 187,197,198}.

In work place ergonomics, an integral part is related to occupational health, safety, and job satisfaction^{5,14,119}. Other perceived environment attributes, neighbourhood and workplace design characteristics are associated with well-being and job-satisfaction^{35,39}.

An *aesthetically* supportive and harmonious physical environment may influence employees' views of their workplaces and their own health^{36,39,43,46,108,180}. Documentations concerning possible influences of design and workplace *aesthetics* on employees are scarce, and the distance between ergonomic and psychological science and the architects' design process can be considerable³⁵.

Aesthetic and ergonomic factors with or without psychosocial effects can be perceived to overlap^{74,135,137,139}. If an independent role of perceived aesthetics as a work-environmental factor could be identified, this might be considered in the promotion of occupational health. As early as in 1972 Maslow and Mints¹²⁹ pointed out effects of "aesthetic" surroundings on energy and well-being. Similar hypotheses have been studied lately in hospital environments^{35,36,44,179}. The influence of hospital design and aesthetics on hospital staff was discussed by Dilani 2005⁴⁶, whereas these factors might likewise be important in other workplaces.

If aesthetics as a work-environment factor could be identified it would be important in the promotion of occupational health. There is little empirical evidence on impact of design and work place *aesthetics* on employees, however.

The question is raised "how important are perceived aesthetics in workplaces"?

8. Musculoskeletal pain and links to stress.

Homeostasis is a summary concept of the mechanisms which collaborate in keeping the body organs' and cells' surroundings as constant as possible including the hormonal and the autonomic nervous system's influence on the organs in "flight-or-fight"-reactions, the body's response to threat.

Allostasis is the body systems' ability to compensate for changes, a stress regulation adapted to longlasting constant arousal (e.g. circulation-system, hormones, metabolism and immune protective system). The allostatic stress theory according to McEwans¹³² states that long lasting under dimensioned or over dimensioned activity in the allostatic system (e.g. circulation-system, hormones, metabolism and immune protective system) is influenced by unpropitious psychological stress. Problems turn up when the energy mobilisation is constant without periods of recovery. Allostatic load is when the individual is in high-speed for months without turning back to balance for healing and recovery. Normal activation and energy mobilisation is healthy and normal in situations demanding energy followed by recovery and is considered salutogenic. The existing theories on links between stress and pain have in common that mental stress has an important impact on each of them. Stress and pain are affected by the same neural pathways and brain structures^{70,71}.

Neck-shoulder and back pain as considered to be multi-factorial and commonly stress related^{14,49,90,101,139,152,173} connects to an experience, which is not directly related to psychological stress but might be related, is that long lasting load was shown to cause a selective overexertion of low-threshold motor units, the "Cinderella hypothesis" according to Hägg 1991¹⁹³. This has become a popular hypothesis to explain musculoskeletal complaints at low biomechanical exposures. The paradox of manifest injury risks at only a few percent of the EMG activity level at maximal voluntary contraction (%EMG_{max}) can be understood in the light of this hypothesis, provided the low-level muscle activity represents sustained activity in a few motor units. The exposure-effect associations were high-lighted.

The gender perspective of pain with a higher prevalence of MSP in females^{109,164,171} has been discussed and some researchers have suggested that female gender is a risk factor in itself while others suggest different approaches to research.

The prevalence of neck-shoulder-back pain is high as earlier mentioned^{3,81,164}. A study was performed simultaneously with this thesis work which was focused on pain and perceived pain relatedness to stress during one year^{88,89}. The longitudinal design was chosen, three measurements with 6 month intervals, to standardize considering the year time variations. The questions addressed the previous month on each occasion. A group of news media workers was compared with a group of work-room staff with a more physically demanding work. Mean of three occasions were analysed. There were no significant difference in upper back pain (ns) whereas neck, shoulder, and low back pain levels (VAS 0-10) were lower in the news media worker group ($p < 0.001$), as depicted in Figure 1a. The level of stated pain relatedness to stress (scale 0-3) pointed to a higher level among news workers whereas low back pain relatedness to stress was higher among the work-room staff ($p < 0.001$), Figure 1a. The average prevalence of any pain occurrence in anatomical regions showed according to news-workers a similar or just slightly lower risk for pain than the work-room staff, RR close to 0.9-0.95, except for low back, RR 0.7. The reported prevalence of "pain relatedness to stress" in news media workers compared to work-room staff showed RR close to 1 in upper back, whereas it was higher, RR 1.1, in "neck pain relatedness to stress" and in "shoulder pain relatedness to stress", and lower in "low back pain relatedness to stress" RR=0.7, Figure 1 b. The average prevalence of any shoulder pain for the previous month was 70% for news workers and 75% for work-room staff, while perceived stress relatedness to shoulder pain showed opposite circumstances, 55% and 50%, respectively.

The relationship between stress and pain in the locomotor system has been investigated from several perspectives^{14,49,101,125,172}. In groups of workers with shoulder pain and physically

demanding occupations, Lundberg et al ¹²⁶ found a rise in catecholamine excretion as well as a rise in blood pressure. Kaergard et al ⁹¹ found associations between neck and shoulder disorders and low levels of testosterone in female workers and Wiholm et al ¹⁹⁴ found a relationship between testosterone levels and upper extremity pain in knowledge workers.

However, to our knowledge, as earlier commented, there are only limited studies on the associations between stress biomarkers and musculoskeletal pain (MSP) in a working population, while in patients with chronic MSP, associations between pain and biological stress markers have been described ^{7,59,69}.

There are a few previously published studies on patient samples with chronic pain and acute pain on the relationship between stress biomarkers and pain in the locomotor, however. Hasselhorn et al ⁶⁹ found that endocrine and immunologic variables, i.e. low MHPG (methyl 5hydroxy phenylethylene glycol=reflecting sympathoadrenomedullary activity), low DHEA-S, and low β -endorphin predicted a poor six month prognosis of low back and neck-shoulder pain in a female patient group. Tritilanunt et al ¹⁷⁶ found pain-related changes in serum HDL in a patient sample with chronic low back pain. A dysregulation of the hypothalamic - pituitary – adrenocortical - axis (HPA-axis) in patients with fibromyalgia syndrome and in patients with low back pain was found by Griep et al ⁵⁹ and Anderberg et al ⁷.

It remains unclear whether similar associations between stress biomarkers and pain can be found in a healthy working sample with mild to moderate neck-shoulder-back pain, and whether stress biomarkers can predict self-reported pain occurrence and intensity. Of particular interest is to study this issue in a stress and computer intensive population .

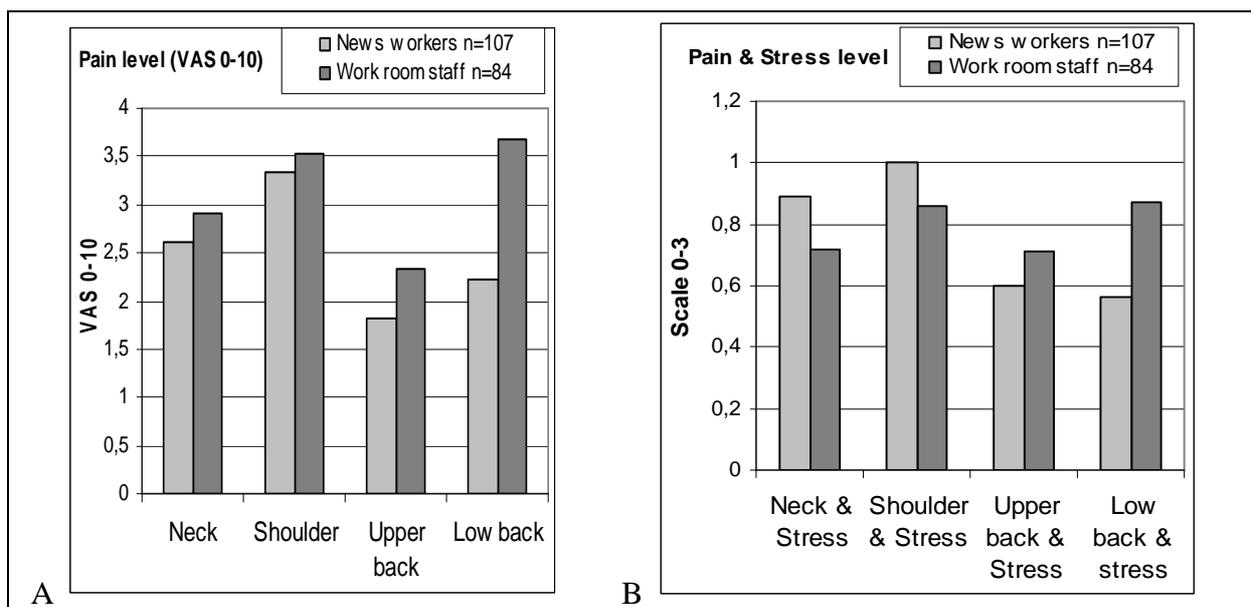
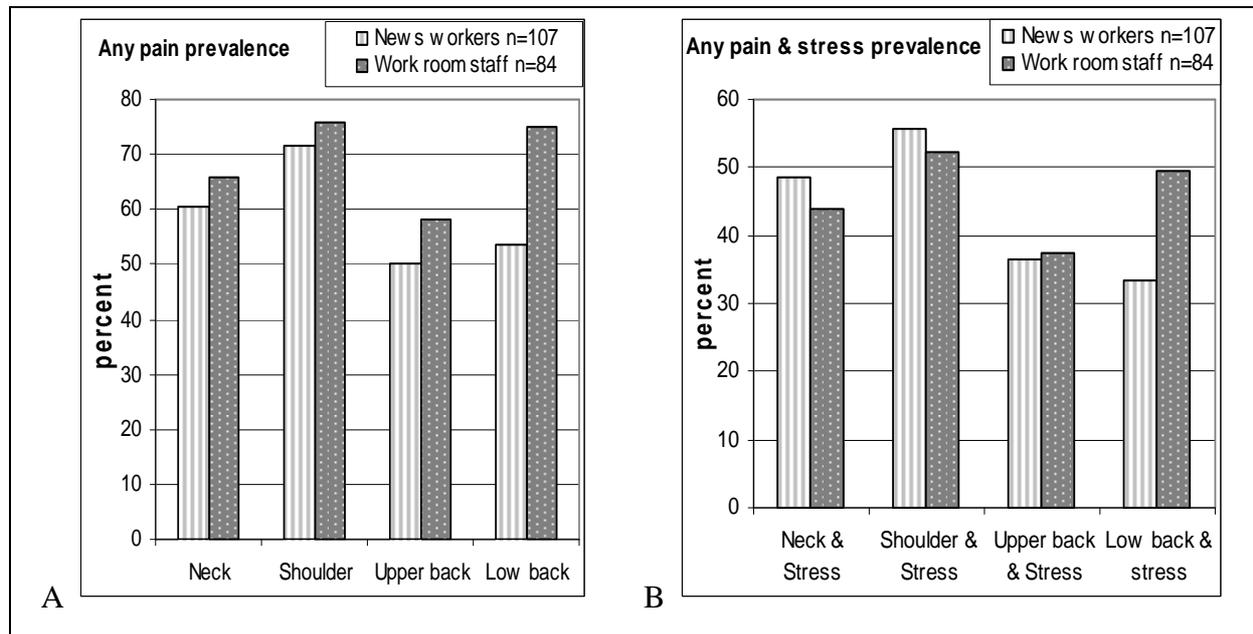


Figure 1 a) A. Pain levels in body regions (VAS 0-10). B. Levels of perceived “relatedness to stress” (scale 0-3). News media workers and work-room staff with mainly a more physical demanding work

situation in comparison. Average level is shown with regard to the previous month at three occasions (month 0, 6 and 12). The differences were significant between groups in low back and “low back pain relatedness to stress” ($p < 0.001$).



1 b) A. Prevalence of any pain. B. Prevalence of any perceived “pain relatedness to stress”. Average percent is shown of three measurements with regard to the previous month at each occasion (month 0, 6 and 12). Neck and shoulder showed opposite circumstances in A and B.

9. Measurements

In epidemiological and other large population studies the interview or questionnaire methods are mainly used with additional register data. There is a multitude of validated international and national questionnaires addressing population health and ill-health^{20,55,78,109,110,118,164,168,170,175}. Those questionnaire tools are extensive and time consuming for the respondent. They are also staff demanding and too expensive to be used in ongoing working life. However, epidemiological research publications are very useful as references to other studies.

An aspect on performing questionnaire studies as compared to physical measures for example is that there is recall bias and that dishonest reporting might occur. The larger the population is and the higher the response rate is, the better conclusions can be drawn, provided that validity and reliability are sufficient^{86,87}. Recall bias may be amplified when responses cover a long preceding period, according to some authors⁶⁴. On the other hand responses regarding immediate situations may give rise to error also.

In a parallel, yet unpublished study to this thesis, differences were shown in pain in each of neck, shoulder and low back, when covering the last week as compared to the previous 12 months ($p < 0.001$), ($n=798$) showing lower levels and prevalence for the last week. Not to forget that there can be a real variation over time. Similar results were seen for perceived “pain relatedness to stress” and for “pain relatedness to work posture/load”, with regard to neck and shoulder ($p < 0.001$) and low back ($p=0.007$). In comparisons between population studies on questionnaire responses the covering period consequently is of high importance.

Objective measures as for example oxygen uptake, blood testing and physical tests are advantageous for examining health status but less practical in large populations. They are time consuming and cost demanding. For studying some sociodemographic conditions, perceived stress and pain, individual statements are needed as well.

To perform a study in a busy work-life demands limitations in method choice. Otherwise the study may become unmanageable. It still was to cover a broad area of working life and work health factors. Pre-validated questionnaires and register data from company files were used and national statistics we added on. Objective blood testing and physiological measures were performed.

10. Study population and external professional employee population

In addition to the current project, the study population at Swedish Television and Swedish Radio symphony Orchestra (n=1961, age 21-67 yrs) (Study I and IV) was compared with a population sample which was matched with regard to age, gender, time period and professional status (n=3300, age 21-67 yrs). This sample was collected in collaboration with Statistics Sweden, from their survey on living conditions ^{164,170}. The rationale behind this comparison was the examination of the study population's comparability with a 'similar occupational status sample' of Swedish working population with regard to the studied variables, as described in Table 1.

Table 1. Comparison between the main study population (n=1961) and gender reference groups from Statistics Sweden (n=3300) adjusted for age, time period and occupational status ¹⁶⁴. The non-significant p-values and RR (=relative risk) for the study population are in **bold**.

Variables	Study I Age-adjusted male % n= 1040	Reference male % n= 1800	P-value	χ^2	RR	Study I Age-adjusted female % n= 920	Reference female % n= 1500	P-value	χ^2	RR
Health factors										
Perceived good health	70.1	87.3	<0.001	144.0	0.8	69.0	82.6	<0.001	63.3	0.84
Sleep disturbance	41.4	20.2	<0.001	144.0	2.1	50.0	30.2	<0.001	90.6	1.66
Neck-shoulder pain	38.6	25.7	<0.001	51.9	1.5	51.4	45.7	0.019	51.9	1.1
Back pain	28.9	26.2	0.127	2.4	1.1	31.6	31.6	0.686	0.17	1.0
Worry for own health	56.0	28.7	<0.001	202.4	2.1	62.0	38.0	<0.001	132.9	1.63
Worry / anxiety	29.2	12.6	<0.001	115.9	2.3	40.6	20.6	<0.001	117.0	1.97
Seeing a doctor	36.2	29.5	<0.001	13.6	1.2	43.8	38.2	0.007	7.3	1.2
^{a)} Sick-leave females and males (F & M) #	3.4 F&M	5.6 F&M	-	-	0.6	3.4 F&M	5.6 F&M	-	-	0.6
^{b)} No sick-days at all #	58.0	40.0	-	-	1.5	47.0	27.0	-	-	1.7
Work-environmental factors										
Disturbing noise	49.3	23.7	<0.001	193.0	2.1	47.6	27.8	<0.001	99.4	1.7
Learning new things at work	76.2	80.9	0.003	9.3	0.9	73.1	77.4	0.021	5.5	0.94
Heavy lifting	22.0	18.0	0.009	6.9	1.2	7.2	17.9	<0.001	53.6	2.49
Bent and twisted work positions	29.7	16.7	<0.001	65.5	1.7	18.2	21.3	0.060	3.6	0.85
Psychologically demanding work	70.6	51.6	<0.001	99.6	1.4	69.6	63.1	0.001	10.9	1.1
Influence on working hours	55.1	83.1	<0.001	252.0	0.7	59.3	75.5	<0.001	70.5	0.79
Influence on what is performed at work	74.5	70.7	0.028	4.8	0.7	69.5	60.9	<0.001	18.5	1.14
Influence on how work is performed	87.2	89.4	0.075	3.2	0.98	88.7	84.0	0.002	9.3	0.97
This job is something special	89.5	89.7	0.831	0.05	0.99	89.7	91.7	0.112	2.5	0.98
Working evenings \geq once a week or more	62.4	42.8	<0.001	101.1	1.6	49.3	31.8	<0.001	75.1	1.55
Sociodemography										
General living circumstances (good 7-10)	68.6	89.5	<0.001	189.8	0.77	67.3	88.5	<0.001	190.6	0.76
General living circumstances (poor 0-4)	2.0	9.1	<0.001	88.0	0.22	2.4	9.6	<0.001	89.2	0.25
Economic problems	13.9	9.2	<0.001	15.4	1.5	11.8	10.6	0.021	5.3	1.1
Threatened by or exposed to violence	5.4	3.9	0.069	3.3	1.4	4.7	3.2	0.013	6.2	1.47
Life style										
Alcohol intake once/week or less	60.0	76.2	<0.001	82.0	0.79	65.0	85.0	<0.001	133.0	0.76
Physical training, regularly 1/w (exercise)	45.3	65.5	<0.001	110.1	0.69	51.1	69.7	<0.001	85.7	0.73
Daily smoking	9.5	11.8	0.164	2.0	0.81	12.4	15.2	0.064	3.6	0.82
^{c)} Daily snuff taking \square	20.0	21.9	-	-	0.91	4.1	7.6	-	-	0.54

Swedish general population: ^{a)} Sick-leave ¹⁶⁴ ^{b)} Vogel ²⁰¹; Occupational status adjusted: ^{c)} The Swedish National Institute for Public Health 2004 ¹⁷⁰

11. Overall objective to this thesis

Why study employees in broadcasting environments?

Health determinants in a positive sense - and not only determinants of ill health ^{40,41,42,57,68,99,101,104,124,128,137,143,149,178,187,197} in rapidly changing work environments, are required for public health promotion work. Therefore the aim of this thesis is to identify conditions predicting future work health development ³¹.

All different professional employees (salaried employees, white collar workers) at the Swedish television public-service broadcasting company and all news workers as well as the symphony orchestra members in the Swedish radio public-service company were chosen for the thesis studies.

The results might provide a basis for further prospective research, on health determinants and salutogenic predictors. The overall aim was to contribute to facts and suggestions for future health promotion and prevention development in working life.

AIMS

The overall aim of the work presented in this thesis was to identify determinants of work health in white-collar workers and professional employees with regard to work environment, organisation and individual health factors, in particular those with special reference to stress. Stress biomarkers and perceived work-related stress, musculoskeletal pain in neck-shoulder-back, sleep disturbance, life style, age, gender and absence of sick-listing (termed ‘well-listing’) were included.

A further aim was to develop basis for future studies of modern work health and for cost-benefit analyses in working life.

Specific aims were:

- I to identify health determinants in working life among white-collar workers and professional employees and to identify possible target items for work-health promotion. The focus was on work environment and organization, sociodemographic conditions, health factors and life-style
- II to identify biological stress markers (anabolic, catabolic, cardiovascular, immune markers and neuropeptides) correlations to moderate non-specific pain in neck-shoulder-back including longitudinal changes, predictors of pain and cross-sectional associations in healthy white collar workers
- III to study whether a six-month web-based stress intervention programme has an impact on pain in neck-shoulder-back and on reported ‘pain-relatedness to stress’ in neck-shoulder-back, directly after six month intervention and at 12 months follow-up from baseline
- IV to identify whether a perceived need for improvements to workplace aesthetics correlates with sociodemographic conditions, work organisational and environmental, occupational and individual work-health factors, and to a perceived need for ergonomic improvements.

MATERIALS AND METHODS

This thesis is based on four studies of two sets of participants. The main data was collected in 2003. Collection for Studies II and III lasted for 12 months.

Design Studies I-V

Studies I and IV were based on company register data and a questionnaire. These studies were comparative and cross-sectional, covering the previous 12 months.

Study II was based on blood tests, saliva cortisol, blood pressure, body mass index and questionnaires with observations at base-line and at six and 12 months. The study was in three parts: a prospective, longitudinal six-month follow-up of stress-biomarker and pain change correlations; a 12-month follow-up of the ability of stress biomarkers to predict pain, and a cross-sectional comparison of stress biomarkers between groups with no pain and groups with any pain.

Study III was based on a stress-intervention programme and questionnaires. Study III consisted of a prospective, randomised and controlled stress intervention lasting for six months with a 12-months follow-up from baseline.

Participants and data collection Studies I-IV

All the participants in Studies I and IV received written information and gave informed consent to their participation.

All the participants in Studies II and III received oral information and gave signed consent to their participation.

Participation and data collection flow in all four studies are shown in Figures 2 and 3. Description of all study groups, data sources and study design are given in Table 2.

Questionnaire data were collected by 'paper mail' in all studies. Two reminders were included when needed. An additional questionnaire in Study II was completed at the same hour and place as the blood sampling and physical measurement two occasions at month six and month 12.

Studies I and IV

The participants invited to take part in Studies I and IV (n=2641) were all employees at the companies for public-service television and the public-service radio symphony orchestra who fulfilled the inclusion criteria. Inclusion criteria were employment the previous 12 months and less than six months absence (e.g. studies, childbirth, sick-leave or work abroad).

The personnel managers co-operated in these studies by making available company register data on age, gender, occupation, sick-leave, other absenteeism and work abroad. The television company also contributed information on the internal occupational coding system

and data on long-term (≥ 6 months) sick-listed persons due to stress or musculoskeletal pain in the relevant period. This group was retained as a reference group (Study I). The total sick-leave at the television company was lower than the national rate, RR 0.61.

Another reference group (n=3300) was constituted for Study I. It was matched to the study group with regard to age, gender, occupational status and data collection period. The participants in that group received the same baseline questions as the study group.

In Study I several variables were included in each 'set up'. The 'set ups' were: work environment; work organisation; individual work health; sociodemography and life-style, Table 2 a and b.

In study IV each 'set up' of variables also included several parameters. The 'set ups' were: demography, work environment and organization and health including the same, though not all, parameters as in Study I. (See also Table 4 and 5 in Study IV).

Studies I and IV

- Data was collected from the company registers on age, gender, occupation and sick-leave during the previous 12 months. Based on the company coding system, all the occupations included were sorted into 11 classes for analysis.
- Questionnaire responses were obtained by 'paper-mail'. They related to the previous 12 months or, where stated in the questionnaire - other time periods. The questions included were mainly those as used in other population studies^{103, 164, 170} with additional questions tested for repeatability.
- Reference data (Study I) was gathered as responses from a long-term sick-listed group to a 'short version' of the main questionnaire with questions on stress relatedness to pain in neck-shoulder-back, pain levels and working conditions.
- Reference data was also collected in collaboration and agreement with Statistics Sweden¹⁶⁴ and from web-based register data¹⁷⁰.

Study II

The participants invited to take part in Study II were all news-media workers at three news departments of the public-service television and radio companies.

These studies addressed, all the employees at one television news department in the capital (ABC, local news), and one news department in a medium-sized town (Östnytt, local news), and the Ekot (radio news department in the capital). These departments were selected in collaboration with their respective personnel managers. The participants were simultaneously included in a study by Hasson et al⁷⁰.

All eligible employees were included. They underwent the following measurements: blood sampling, blood pressure, saliva cortisol and body mass index. These tests were performed by a trained nurse and the analyses were undertaken at the Karolinska Hospital laboratory (150). Samples were taken between 08.00 hrs and 11.30 hrs, requiring fasting and no smoking

beforehand. The samples were taken at the same hour on each individual occasion ± 15 min, a) at study start (baseline), b) six months later, and finally c) 12 months later (Table 3).

The participants completed a questionnaire covering the previous month on three occasions: baseline, six months and 12 months. The questionnaire covered age, gender, occupation, pain (VAS 0-10) in neck, shoulder, upper-and lower-back (score 0-40), working hours at computer, and medicine intake due to pain (yes/no) and due to stress/depression (yes/no), (Tables 4 a and b).

An additional questionnaire covering *the same hour* (“h6” and “h12”) as the blood sampling was completed at months six and 12.

Study III

Study III addressed the same participants as Study II and an additional equivalent control group. The Study II participants were randomised to the sub-groups I and II and participated in a web-based stress intervention. The additional equivalent group of all eligible employees at the central television news desk (Nyhetsdesken) in the capital constituted the control group.

All participants in these three groups responded to a questionnaire, equal to that in Study II, addressing the previous month. This was done at study start (baseline), after a six-month intervention and at a post-intervention follow-up 12 months after baseline (Figure 2 and Table 2).

The sub-groups I and II followed a web-based stress-management and health-promotion intervention programme (stress programme). Each group separately received oral information on the programme. Group I had the larger programme (Table 4). Apart from the programme features offered, the participants did their normal work.

The control group worked as normally with no intervention.

Table 2. Study groups, data sources and study designs

	Study I	Study II	Study III	Study IV
Participants n (%)	Study group 1961/2641 (74%) Well-listed 1041 (53%) Not well-listed 920 (47%) Long term sick-listed group 32/40 (80%)	Study group 121/127 (95%) Pain group 100 (83%) No-pain group 21 (17%)	Total study population 233/241(96%) Study group I 55 Study group II 71 Control group 107	Study group 1961/2641 [74%] Persons with need for <i>aesthetic</i> improvement any need 1598 (82%) high to definite need 902 (46%) Persons with need for <i>ergonomic</i> improvements any need 1617 (83%) high to definite need 667 (34%)
Age mean years	Study group: 47.7 (\pm SD 10.5, range 21-67) Female 46.3 (\pm SD10.7) Male 48.8 (\pm SD 10.2) Well-listed 48.8 (\pm SE 0.3, range 21-67) Not well-listed 46.5 (\pm SE 0.36, range 23-66) Long-term sick-listed 50.2 (\pm SD 10, range 32-62)	Total study population 45 (\pm SD10.84) Female 47 (\pm SD 10.2) Male 43 (\pm SD 11.9)	Study group I 44.9 (\pm SD 10.1) Study group II 44.2 (\pm SD11.8) Control group 43.4 (\pm SD 9.7)	Study group 7.7 (\pm SD 10.5, range 21-67) Female 46.3 (\pm SD10.7) Male 48.8 (\pm SD 10.2)
Gender	Female 824 (42%) Male 1137 (58%)	Pain group baseline (previous month) 99 (83%) No-pain group (previous month) 20 (17%) Pain group ("h12" blood test) 34 (32%) No-pain group("h12" blood test) 71 (68%)	Study group I (64/36 %) Study group II (49/51 %) Control group (54/46 %)	Female 824 (42%) Male 1137 (58%)
Occupational groups	11 different occupational groups of professional employees in broadcasting work	News-media workers	News-media workers	11 different occupational groups of professional employees 1961
Study design	Comparative cross-sectional - Between-group analyses	Prospective longitudinal Prospective – regression analyses Comparative cross-sectional	Prospective, controlled, randomized, baseline, intervention (6 m) and follow-up (12 m)	Comparative cross-sectional - Between-group analyses
Data sources	Company file Questionnaire Statistics Sweden	Blood sampling and physical measures Questionnaire	Participation in web-based stress-intervention program Questionnaire	Company file Questionnaire

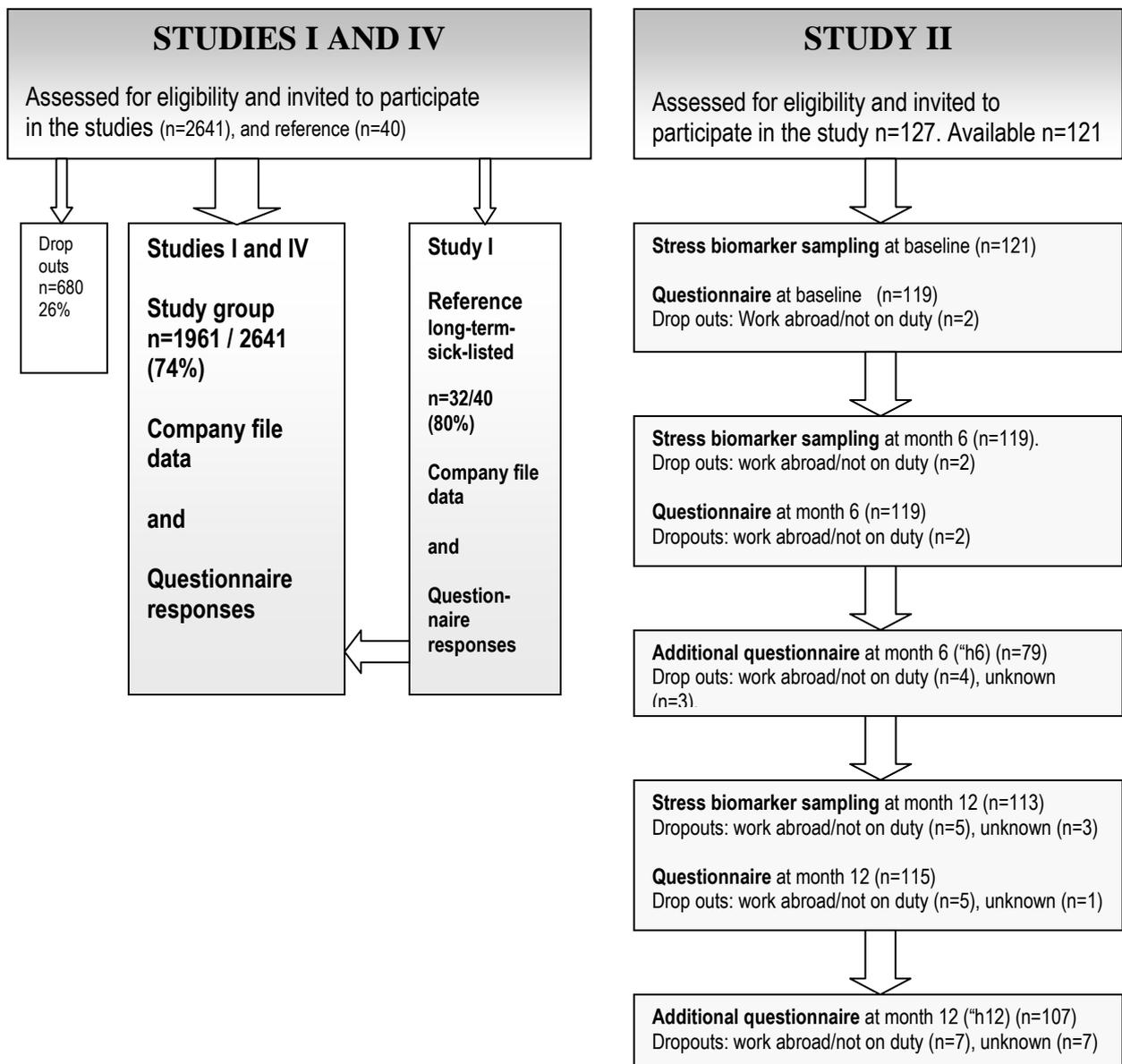


Figure 2. Participation flow through each stage of Studies I, II and IV.

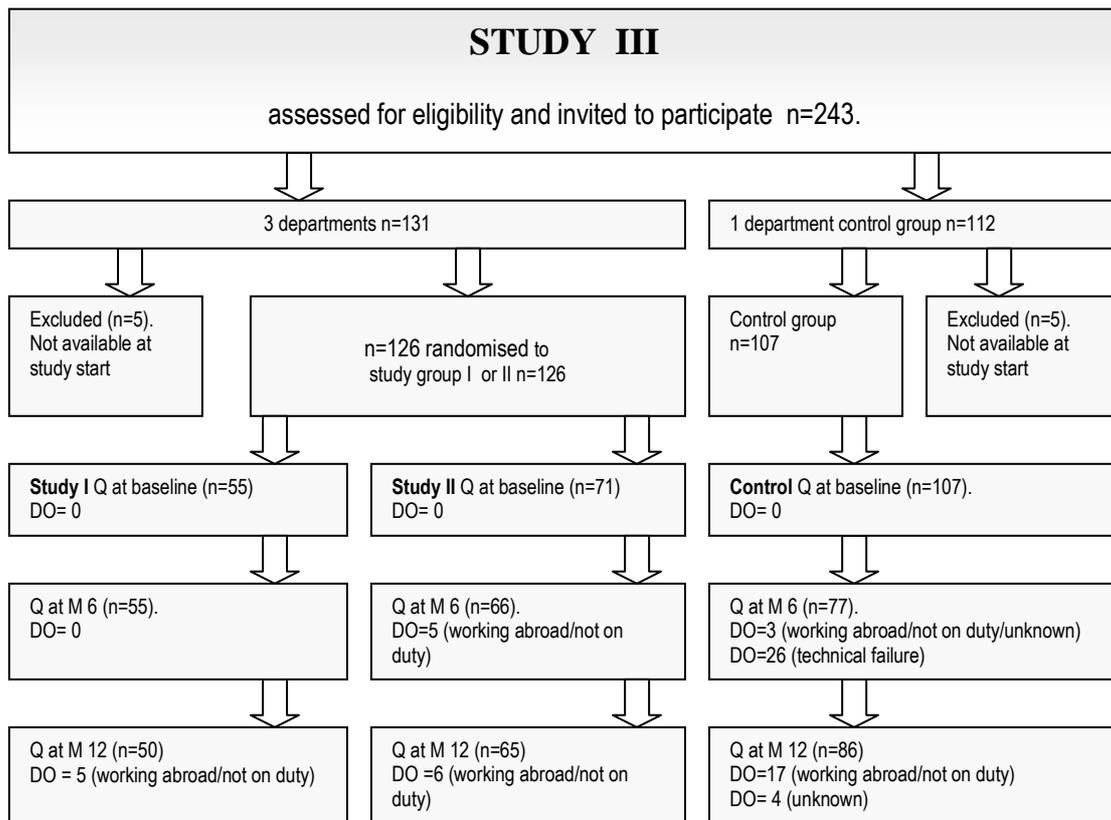


Figure 3. Questionnaire participation flow through each stage of Study III during 12 months. Q=Questionnaire; M=month; DO=dropouts.

Table 3. (Study II) Stress biomarkers: Blood sampling and physiological measurements

Categories	Stress biomarkers
Cardiovascular system and lifestyle	Blood pressure, BMI, P-BNP (brain natriuretic peptide), P-PAI-1 (plasminogen activator inhibitor 1), S-insulin, B-HbA1C, S-triglycerides, S-cholesterol, S-HDL, S-LDL
Stress-related Hypothalamic-pituitary adrenal (HPA)** -axis, (catabolic)	S-prolactin, P-ACTH (adrenocorticotrophic hormone), S-cortisol, S-TSH (thyroid stimulating hormone), S-T3, S-T4 (free), S-urate, S-CK, S-LD, saliva cortisol (x4), S-albumin, P-fibrinogen
Recovery-related (anabolic)	S-growth hormone, S-IGF-1, S-DHEAS-S (dehydroepiandrosterone sulphate), S-estradiol, S-testosterone, S-SHBG (sexual hormone binding globulin), S-gastrin
Immune markers and neuropeptides	S-IL-1beta, S-TNF α (tumour necrosis factor alpha), S-CRP, high sensitive (c-reactive protein), P-substance P, P-endothelin, P-NPY (neuropeptide)

Table 4 (Study I) Questionnaire and company file data 'set ups'. Response categories and dichotomization for statistical analyses. □ = questions from Statistics Sweden¹⁶⁴. P-values for differences between "well-listed" and "not well-listed" after age/gender adjustment. (See also Study I, Tables 4 and 5).

Variable 'set up'	Variables	p
Work environment	Stimulating work (yes definitely and yes often) vs (seldom and not at all) (scale 0-3)	ns
	Support from work colleagues (yes definitely and yes often) vs (seldom and not at all) (scale 0-3)	ns
	Negative work stress (yes definitely and yes often) vs (seldom and not at all) (scale 0-3)	≤0.001
	Problems at work (yes definitely and yes often) vs (seldom and not at all) (scale 0-3)	0.002
	□ This job is something special (yes/no)	≤0.001
	□ Dissatisfaction with work circumstances (VAS 0-10)	≤0.001
	□ Psychologically demanding work (yes/no)	ns
	□ Disturbing noise (yes continuously and yes sometimes) vs (no, not at all)	≤0.001
	□ Physically demanding work (yes/no)	≤0.001
	□ Bent and twisted work positions (yes/no)	≤0.001
	□ Repetitive and one-sided work (yes/no)	≤0.001
	□ Monotonous work (yes/no)	≤0.001
	□ Heavy lifting (yes/no)	≤0.001
	□ Daily perspiration due to work duties (yes/no)	≤0.001
Work health	Sleep disturbances (yes definitely and yes often) vs (seldom and not at all) <i>previous 12 months (Total 54%)</i>	≤0.001
	Sum of pain (VAS 0-10 in neck; shoulder; upper and low back, score 0-40)	≤0.001
	Sum of pain-relatedness to stress (yes definitely and yes often) vs (seldom and not at all) (scale 0-3 in neck, shoulder, upper and low back, score 0-12)	0.001
	Sum of pain-relatedness to work posture/ load (yes definitely and yes often) vs (seldom and not at all) (scale 0-3 in neck, shoulder, upper and low back, score 0-12)	≤0.001
	Been at work despite such bad health that you ought to have stayed at home (yes/no)	-
	Vacation compensation due to ill health (yes/no)	≤0.001
	□ Perceived good health (yes very good and good) vs (very bad, bad and tolerably)	0.031
	□ Worry about own health <i>lately</i> (yes often and yes sometimes) vs (not at all)	≤0.001
	□ Worry/anxiety <i>lately</i> (yes/no)	≤0.001
	□ <i>Seeing a doctor the previous three months</i> (yes/no)	ns
	<i>Medicine intake for stress/depression</i> (yes/no)	≤0.001
	<i>Medicine intake for pain</i> (yes/no)	≤0.001
	<i>Treatment due to stress/depression</i> (yes/no)	≤0.001
	<i>Treatment due to pain</i> (yes/no) ≤	0.004
	□ Pain occurrence in neck/shoulder <i>lately</i> (yes/no)	See table 1 (frame)
	□ Pain occurrence in low back <i>lately</i> (yes/no)	See table 1 (frame)
	□ Sleep disturbance <i>lately</i> (yes/no) (Total 45%)	See table 1 (frame)

Table 4 – Continuation (See also Study I, Tables 4 and 5).

Variable 'set up'	Variables	p
Work organisation	Evident work aims (yes definitely and yes often) vs (seldom and not at all) (scale 0-3) Much to do at work (yes definitely and yes often) vs (seldom and not at all) (scale 0-3) Incompatible work demands (yes definitely and yes often) vs (seldom and not at all) (scale 0-3) Work organisation needs to be improved (yes definitely and yes often) vs (seldom and not at all) (scale 0-3) Stimulating work (yes definitely and yes often) vs (seldom and not at all) (scale 0-3) Support from chief person (yes definitely and yes often) vs (seldom and not at all) (scale 0-3) (yes/no) Computer working h/w Working h/w <input type="checkbox"/> Influence on how work is performed (yes definitely and yes often) vs (seldom and not at all) (scale 0-3) <input type="checkbox"/> Influence on what is performed at work (yes definitely and yes often) vs (seldom and not at all) (scale 0-3) <input type="checkbox"/> Influence on working hours (yes, definitely and yes, often) vs (seldom and not at all) (scale 0-3) <input type="checkbox"/> Working evenings/nights \geq once a week or more (yes/no) <input type="checkbox"/> Learning new things at work (yes/no) <input type="checkbox"/> How do you consider your possibilities to influence your work circumstances e.g general influence (VAS 0-10)	0.010 ns ns ns 0.001 ≤ 0.001 ns ≤ 0.001 ≤ 0.001 0.001 ≤ 0.001 ≤ 0.001 ≤ 0.001 ≤ 0.001 ≤ 0.001
Socio-demography and Life-style	Negative stress privately (yes definitely and yes often) vs (seldom and not at all) Problems privately (yes definitely and yes often) vs (seldom and not at all) Work demand influences on private life (yes definitely and yes often) vs (seldom and not at all) (scale 0-3) Computer work h/w privately Regular meals (yes/no) Body Mass Index (BMI) according to reported height and weight Physical activity (not dressed for exercise) 10-30 min never to \geq three times/w (once a week vs less) (yes/no) Physical activity (not dressed for exercise) 30 min, never to \geq three times/w (once a week vs less) (yes/no) <input type="checkbox"/> Physical training (dressed for exercise) 30 min, never to \geq three times/w (once a week vs less training) (yes/no) <input type="checkbox"/> Daily smoking (yes/no) <input type="checkbox"/> Daily snuff taking (yes/no) <input type="checkbox"/> Frequency of alcohol intake (7 categories from never to daily). Dichotomized \leq 3-4 times/month vs more often (yes/no) <input type="checkbox"/> Economical problems (yes/no) <input type="checkbox"/> Permanent employment (yes/no) <input type="checkbox"/> Experience of threat and violence (yes/no) <input type="checkbox"/> Living in partnership/married (yes/no) <input type="checkbox"/> Children at home (yes/no) <input type="checkbox"/> General living circumstances (yes/no)	ns ns ns ns ns 0.019 ns ns 0.007 0.003 ns ns ns ns ns ns 0.034 ≤ 0.001 ≤ 0.001

Table 5. (Studies II and III) Questions and response alternatives to statements referring to the previous month. The questions 4-8 were additionally used in Study II simultaneously with blood tests, months six and 12.

Parameter	Expressed as
1. Age	Years
2. Gender	Male/Female
3. Occupation	Groups, employer's classification (modified)
4. Working hours at Video Display Unit (VDU) per week	hours
5. Medicine intake due to pain	Yes/No
6. Medicine intake due to stress/depression	Yes/No
7. Pain in:	VAS (0-10) min= 'no-pain', max= "severe pain"
Neck	- " -
Shoulder	- " -
Upper back	- " -
Low back	- " -
8. "Pain and stress" i.e. self-rated relation between pain, if any, and stress in:	No, not at all=0; some degree=1; high degree=2; definitely=3 (score 0-3)
Neck	- " -
Shoulder	- " -
Upper back	- " -
Lower back	- " -

Table 6. (Study III) The web-based stress programme and features included for groups I and II, respectively. Groups I and II differed through the addition of features for cognitive reframing, relaxation exercises and "chat" in group I.

Feature	Group I	Group II
Monitoring tool for stress and health levels with instant feedback; graphs illustrating current and retrospective ratings and an option to compare results with other groups with the same socioeconomic profile, within the same department/company and all the respondents in the database. Questionnaire compiled as a ten-item questionnaire for regular or daily usage.	Yes	Yes
Diary connected to the monitoring tool so that ratings and notes could be compared and examined retrospectively. Diary used as stress management tool but also for improving self-knowledge and understanding of how different events affect health and well-being.	Yes	Yes
Popular-scientific information on stress and health compiled by various Swedish researchers.	Yes	Yes
Self-help in the form of classical stress management exercises for relaxation and sleep improvement, cognitive reframing, time-management, emotional control and self-knowledge, strengthening self-esteem, life reflection, and dissociation.	Yes	No
"Chat" possibility	Yes	No

Analyses

Comparative analyses between groups were performed in all the studies. In Studies II and III prospective longitudinal analyses were performed^{4, 26, 33}.

Before most of the analyses the VAS (scale 0-10) for pain in neck, shoulder, upper- and lower-back was summed to score 0-40 and with other musculoskeletal pain included to score 0-50. The scales (0-3) for 'pain relatedness to stress' and for 'pain relatedness to work posture/load' regarding neck, shoulder, upper and lower back were summed to score 0-12 in most of the analyses.

This was done to reduce the number of subgroups. Separate analyses by body region and/or gender were also performed in Studies II, III, and IV.

To limit the number of age and gender subgroups, age and gender were adjusted for. Stress biomarker variables that were somewhat skewed distributed were logarithmized prior to analysis (Study II).

The scales and scores were dichotomized to “yes” and “no” when appropriate.

The tests and analysis methods used in the studies are presented in Table 7.

Table 7. Statistical methods

Analyses	STUDY I	STUDY II	STUDY III	STUDY IV
SPSS 15	x	x	x	x
Descriptive statistics				
Frequency	x	x	x	x
Median	x	x	x	x
Mean (range, SD, SEM)	x	x	x	x
Analytical statistics				
Spearman’s correlation test	x	x	x	x
Pearson’s correlation test		x		
Chi-square test and Chi-square analyses for trend	x	x	x	x
ANOVA one-way, post-hoc test, repeated measures	x	x	x	x
Student’s paired <i>t</i> test, and independent <i>t</i> test				
Kolmogorow-Smirnov test		x	x	
McNemar test				x
Exact sign test				x
Logistic regression, univariate and multivariate	x			
Linear regression, univariate and multivariate	x	x		
Odds Ratio (OR)	x			
Relative Risk (RR)	x			x
Logarithmical transformation		x		
- CLT = Central Limit Theorem according to Wayne, which permits sampling from not-normally-distributed populations with a guarantee of approximately the same results as would be obtained if the populations were not normally distributed, provided that we take a large sample” cited from Altman ⁴		x		
- LSD = Least sign difference. Thesis of the linear combination of independent normally distributed variables (SPSS 9.0 manual).				x
- LCI = Thesis of the linear combination of independent normally distributed variables ²⁶ .			x	
Confidence interval 95%	x	x	x	x
p<0.05 (two-tailed) and, Study II, also p<0.10	x	x	x	x

Ethical approval

Ethical Research Committee North at Karolinska Institutet (Dnr 02-199) approved Studies I and IV. All participants gave informed consent to their participation.

The Karolinska Institutet Ethical Committee (Dnr 01-355) and the Ethical Committee at Uppsala University (Dnr 01-188) approved Studies II and III. All participants signed consent to their participation.

RESULTS

Study I

Between participants in the study population (n=1961/2641) and dropouts there were no significant differences with regard to age, gender or education. Nor was there any difference between in the participation rate between different parts of Sweden. Females constituted 42%, males 58%. Mean age was 48 yrs, females were 46.3yrs, and males were 48.8 yrs.

Fifty-three percent were well listed (i.g no sick-day the previous 12 months). Of the females 47% were well-listed and of the males 58%. The well listed were mean 2.5 yrs older than the not well-listed, most evident in the males.

The persons long-term sick-listed 32/40 for stress/depression and musculoskeletal pain showed more pain and pain relatedness to stress, were using more medicine and reported more computer work hours (when at work). This group averaged 2.5 yrs older than the whole study population.

Treatment for pain in neck-shoulder-back was reported by 32% and the treatment for stress-depression by 15 % of the study population. Any pain in neck-shoulder-back was reported by 86%, negative work stress by 74 % and negative stress outside work by 47%. Pain relatedness to work posture/load was reported by 80%, pain relatedness to stress by 67% and sleep disturbances by 45% (*lately* by 54%). Medicine intake due to stress was reported by 11% and due to pain by 17 %.

There were differences in the study population between well-listed and not well-listed employees with regard to all study 'set-ups' included: work environment, organization, work health, sociodemographic conditions and life-style.

After age and gender adjustments statistically significant ($p < 0.001$ to 0.030) (OR 1.1-2.6) health characteristics were found, Tables 3 a and b. (See also Table 4 and 5 in Study I).

In a stepwise multivariate logistic regression analysis, only strong determinants (Wald-value ≥ 20 and $p < 0.001$) were included. The superior health predictors according to the regression analyses were expressed as by OR *more* perceived good health (OR 1.9), working evenings/night/weekends once a week to often (OR 1.8), support from superior (OR 1.6), influence on working hours (OR 1.5), and *less* monotonous work (OR 1.6), working bent and twisted OR 1.5), been at work despite ill-health (OR 1.4), pain in neck-shoulder-back (OR 1.3), work stress (OR 1.3), sleep disturbance (OR 1.25), and male gender (OR 1.5). General living circumstances, worry about own health and heavy lifting on the other hand did not show significance in the regression analyses.

Other health predictors with OR > 1.5 after adjustment for age and gender according to univariate analysis were *more*: stimulating work and *less* disturbing noise, physically demanding work, pain relatedness to work posture/load, daily smoking and worry about one's own health.

There were significant differences ($p < 0.001$) in well-listing between the 11 occupational groups. These differences were stronger (Wald 80.96) than between educational groups (Wald

17.86) in the study population. Between the occupational groups there were significant differences with regard to the variable 'set ups'. A factor showing no significant difference between occupational groups was treatment due to stress which was reported by 15% on average.

Study II

Levels of stress-biomarkers' values were compared in media workers without and with pain in neck-shoulder-back in the following three separate analyses.

Prospective longitudinal analysis was performed to see if increase in pain was followed by less beneficial/negative changes in stress biomarkers over time and conversely. Changes in pain levels and stress biomarkers within an interval of six months showed beneficial changes in the following stress markers: P-NPY, S-albumin, S-growth hormone and S-HDL when pain decreased, and conversely when pain increased.

Stepwise linear regression analysis showed significant predicting values at the base line for pain 12 months later in lower S-DHEA-S (anabolic), higher S-albumin (catabolic) and P-fibrinogen (catabolic), and B-HbA1c (cardiovascular/life-style). After age and gender adjustments, the associations with S-DHEA-S remained statistically significant.

Cross-sectional analysis of differences in stress biomarkers in groups of 'no pain' and 'pain' showed less beneficial stress biomarker levels ($p < 0.05$) in the "pain" group after age and gender adjustments in S-DHEA-S and P-endothelin, S-insulin and P-fibrinogen. Analyses of each gender separately, adjusted for age, revealed in males differences in S-insulin, P-endothelin and additionally in saliva cortisol 3. Also tendencies were seen in BMI, P-fibrinogen, and S-testosterone differences. In the female 'pain' group a less beneficial P-BNP level was found.

Study III

A prospective controlled intervention of six months duration, and post intervention follow-up (12 months) with a web-based stress management and health promotion programme was performed in two study groups at different intensities. The outcome was evaluated with a questionnaire and the responses were compared with a control group with the same kind of occupation and work environment but with no intervention.

Between the three groups there were no significant differences in pain intensity (neck-shoulder-back, score 0-40) or in 'pain relatedness to stress' (score 0-12) at any study point, baseline, six months or 12 months. (See also Table 6 in Study III).

However, within groups, the study group with the less intensive programme had improved in perceived 'pain-relatedness to stress' at the 12 month follow-up. Between baseline and after six months intervention the intervention group with the more intensive programme showed decreased low back pain, and the control group showed less pain-relatedness to stress. Within group differences varied according to pain location and some significant changes were seen in subgroup analyses, though these were not consistent. (See also table 6 in Study III).

Study IV

Associations between reported need for *aesthetic* work place improvements on one hand and demography, work environment and health factors on the other among professional employees with several occupations were studied cross-sectionally. Simultaneously a study of *ergonomic* need for work-place improvements was performed for comparison.

The responses, in the total study group, to the need for *aesthetic* improvements and to the need for *ergonomic* improvements showed significantly ($p < 0.001$) different distributions: 58 % responded differently. (See also table 3 in Study IV).

The responses in the 11 included occupational groups to *aesthetic* needs showed different distributions between groups ($p = 0.006$). The same was valid for *ergonomic* needs ($p = 0.003$). *Aesthetic* needs were more frequently reported as 'high ranking' (yes definitely and yes to a high degree) than *ergonomic* needs were ($p < 0.001$), whereas the groups reporting no 'needs at all' were similar, namely less than one out of five for both.

'High ranking' perceived need for aesthetic improvements as compared to 'low ranking' showed associations to stress, sleep disturbances, problems at work, psychologically demanding work, musculoskeletal pain, and age ($p < 0.001-0.040$). Gender and physical training did not differ between 'high ranking and low ranking' respondents.

The independently tested associations were similar to, but fewer than those for ergonomic needs with regard to the variable 'set ups': demographics, work environment and health ($p < 0.001-0.036$). Sick leave and pain were more strongly related to ergonomics. Neither correlated to gender, but both correlated indirectly to age.

Table 8. Overview of hypotheses/questions in the thesis (Study 1-IV) and summary of results.

Hypotheses and Questions	Results	Study
<p>1. There are no differences between a group of employees with no sick-listing (well-listed) and a group with moderate sick-listing (long term sick-listed excluded) with regard to work organization and environment, work health and sociodemographic and life-style factors.</p> <p>2. There are no differences between occupational groups regarding work organisation and environment, stress, work health and sociodemographic factors and life-style factors.</p> <p>3. There are no differences between the study population (less than six months leave) and people on long-term sick-leave for stress/depression or pain (more than six months leave) regarding musculoskeletal pain in neck-shoulder-back, perceived pain related to stress and to work posture/load, medicine intake, working hours, or computer work hours</p>	<p>rejected</p> <p>rejected</p> <p>rejected</p>	<p>I</p>
<p>There are no differences between the study population and a reference group of occupational professionals from Statistics Sweden regarding work organisation and environment, work, health and sociodemographic/life-style factors.</p>	<p>partly rejected, partly corroborated</p>	<p>Thesis' frame story</p>
<p>Are there:</p> <p>1. associations between long term changes of pain in neck-shoulder-back and stress marker values (six months time frame).</p> <p>2. stress biomarkers with predictive value for pain (12 months later).</p> <p>3. associations between reported neck-shoulder-back pain (VAS) on one hand and stress-related (catabolic), recovery related (anabolic) variables, cardiovascular/ lifestyle factors, immune markers and neuropeptides on the other hand.</p>	<p>corroborated</p> <p>corroborated</p> <p>corroborated</p>	<p>II</p>
<p>Are there:</p> <p>1. measurable changes of summed levels of reported 'pain relatedness to stress' (neck, shoulder, upper - and lower- back) and considering the separate anatomical location, and genders - to a web-based stress intervention programme?</p> <p>2. measurable changes of summed levels of reported 'pain' (neck, shoulder, upper- and lower- back) and considering the separate anatomical location, and genders - to a web-based stress intervention programme?</p>	<p>no</p> <p>no</p>	<p>III</p>
<p>1. There are no associations between "aesthetic" need for improvements and demographics, work environment and organization, health, and between occupational groups.</p> <p>2. There are no differences between distribution of questionnaire responses regarding "need for aesthetic improvements" and "need for ergonomic improvements".</p>	<p>rejected</p> <p>rejected</p>	<p>IV</p>

DISCUSSION

General discussion

The objectives of the present thesis were to study and suggest determinants, characteristics and predictors for work health. Studies of the participants' ongoing working life were included, so as to elucidate occupational factors and future implications for work health.

Health determinants and health predictors respectively were identified in the four studies. The items examined were: the relations of stress bio markers to moderate pain in neck-shoulder-back as compared to no pain; effects of a stress-intervention programme; absence of sick-leave on one hand and work environment factors including work organization, work environment, occupational position, perceived work place aesthetics, sociodemography, life-style, and individual health factors.

Relations between anabolic and catabolic stress biomarkers and moderate pain in a working population were found (Study II). Furthermore it was shown that stress-biomarkers predicted pain intensity in a 12 months perspective (Study II). A web-based stress intervention (RCT) did not influence the reported neck-shoulder-back pain (Study III) indicating that a stress intervention might not be sufficient for pain prevention; broader and multifactor intervention methods such as guided personal work-technique, ergonomic and organizational adaptations, should be applied in future studies ^{5,27,28,29,64,83,94,117,127,134,167,199,200}.

The socio-demographic and life-style factors (Study I) were weak or non determinants for moderate sick-leave (not well-listed) in comparison with no sick leave (well-listed). These findings differ from those for long term sick-listing, which correlate with sociodemographic factors ^{3,118,119,120,123,124,133,137}. Nor did much to do at work and psychologically demanding give rise to any significant differences, factors which were highly rated in both groups. Stress outside job, being much lower than reported work stress, did not show differ between the well-listed and not well-listed. Perception of work-place aesthetics were related to health and work environmental factors. The latter factors also differed by age but not gender.

Further work environment and individual health factors were determinants of well-listing (Study I). These were support from superior; low ratings of pain, stress and sleep disturbance as well as a high degree of influence on work and on working hours. The well-listed group was on average older than the not well-listed. Males were more often well-listed than women ^{3,110,124,164,171}. A long term sick-listed reference group in the company was older than the study population. This accords with previous literature. The television company's total sick-leave level at the time for the studies was lower than the national average (i.e. RR 0.61). Consequently the study population, might be representative of a group of "healthy workers" ^{124,164}, especially since the long term sick-listed persons were excluded in accordance with the purpose of the study: to ascertain whether the same determinant factors or not are found before sick-listing becomes long-lasting, as when it already is long-term.

The overall results for health determinants partly confirm earlier findings ^{3,139,171}. However predictors for moderate sick-leave differed from those of long-term sick-leave, which was obvious for sociodemographic conditions such as economic problem, family situation, immigrant background, and negative stress and problems outside work. The factors *less* sickness presenteeism, musculoskeletal pain, negative work stress, sleep disturbances and disturbing noise were strong determinants for health as was support from superior.

The study findings with regard to well-listing in combination with changes in stress biomarker levels when pain is moderate, should be considered in future work-health promotion.

Methodological considerations

The strengths of study I and IV are the large study population of working people, almost 2000 persons, and a high rate of participation. The drop outs did not differ significantly from the study participants in age, gender or education. Studies II and III include fewer participants. These studies were prospective and longitudinal, the groups are large enough for scientific statistical analyses.

The sick-leave, occupation, age and gender data were documented in detail in the company files. However a recall bias cannot be ignored in the questionnaire-based parts.

The cross-sectional design and use of questionnaire have known limitations. Such study designs allow, no conclusions as to causal connections. According to Rugulies et al ¹⁵⁴, the questionnaire as a study method for large population groups is superior whereas self-reporting, for measuring work load is questioned by Heinrich et al ⁷³. Dane et al ³⁸ recommended questionnaire as very useful for studies of ergonomic exposure. According to Linton S 2005 ¹²² cross-sectional and prospective results show similar results. This was found with regard to psychological variables being relevant very early on, and may be important targets for pain prevention programmes.

The design in Studies I and IV, with questionnaires similar to those used in national population studies, permits comparisons ^{103,115,164,170} and gives a basis of occupation, work organization and individual-related items for future prospective analyses. A comparison was also performed using data from Statistics's Sweden with a matched sample of professional employees ¹⁶⁴. The main part of the questionnaires used had been pre-validated. A few additional questions were tested for repeatability within the present work, with acceptable results. Questionnaires attributing perceived relatedness between pain and stress and between pain and work posture/work load showed satisfactory in repeatability, and better than for visual analogue scale (VAS).

In study I the study population was divided into two groups "well-listed" (0 day sick-leave) and "not-well-listed" (≤ 6 month sick-leave). A few days off in a year may be considered very normal. The author's chosen cut-off point was meant to avoid confounders due to a hazardous chosen number of days "as normal".

To limit the number of subgroups, all analyses were adjusted for age and gender. Functional differences were seen for several of the factors studied. At the same time there were also some significant differences showing a low OR-value (Study I). This should be taken in account when interpreting the results.

The purpose in Study IV was to capture subjective evaluations of perceived need for aesthetic improvements and of perceived need for ergonomic improvements. These items were not defined in detail in the questions. The definitions of aesthetics varies in different publications ^{36,43,44,129,196}. The decision to leave to respondents to judge what was meant by work-place aesthetics and ergonomics should be considered when interpreting the results.

The Study II was prospective over a 12 months and involved healthy workers. The aim was to study whether associations exist between stress biomarkers and self-rated pain in a normal “white collar” working population with stress and computer-intensive work. Previous studies on this issue are rare. The stress-biomarker sampling was performed by a trained nurse and the analyses were conducted at Karolinska Hospital laboratory¹⁵⁵. Blood was sampled at the same time of the morning \pm 15 min (fasting) on all three occasions (base-line, six and 12 months later) representing different times of the year. Hormonal variations for women were not considered. This may have introduced random error. Gender-dependent markers were presented separately for males and females if significant differences at baseline were found. Age and gender adjustments were performed. For the predictive analyses the tests were performed at the same time of the year to avoid season dependent hormonal variations shown by Myrianthefs P et al¹³⁸.

The findings in Study II are based on analyses longitudinally within a six months time frame of pain and stress biomarkers’ relation with regard to pain intensity changes; with regard to stress biomarkers’ predictive value for pain in a 12 months time frame (stepwise multivariate linear regression analyses), and finally cross-sectionally on one occasions. Associations between stress biomarkers and self-rated pain were found for all three test instances. The biomarkers showing significance were only partly the same in the longitudinal and cross-sectional tests. However, we examined a number of factors with differing characteristics. The differences between those markers can be explained by breakdown and duration (e.g. long-term and short term variability). Prospective and cross-sectional analyses are therefore likely to provide different correlates.

In the cross-sectional analysis, fewer statistically significant differences in stress biomarkers between groups of “no pain” and “pain” were found in females despite their higher pain intensity. A possible reason is the smaller size of this subgroup. Other reasons are unknown and need further study.

In Study III a randomization took place constituting groups I and II from three similar news departments with media news workers⁷⁰ and one control group from a similar news department was included in the study. The groups I, II and the control were matched with regard to work characteristics and work organization during the study period.

A preventive web-based stress-intervention was run in groups I and II with a more intensive programme for group I than for group II. The control group had no intervention. All three groups worked as normal during the 12 months period in this RCT-study.

Many analyses were performed, so the risk of mass significance cannot be avoided or ignored. Adjustments for mass significance effects, such as using a more strict p-value $p=0.010$ or Bonferroni corrections^{4,33} are not necessarily good solutions to the problem that several tests may be randomly significant when many statistical analyses are being performed. Such corrections cannot be used in each individual test. Excluding findings with p between 0.05 and 0.01, for instance, could risk missing true associations and accepting a finding with p 0.01 could still be accepting a random finding. For this reason we chose to present all findings with $p \leq 0.05$. The number of statistical tests was used as a background for a discussion of mass significance. The biological plausibility of the pattern of significant findings makes it likely that most of the associations are true, although some of them may indeed be random. An exception was in Study II where also tendencies cautiously were considered in the results.

Clinical relevance was not taken into account as the thesis aim was to see whether associations were seen within a “healthy working population”. Both clinical and functional results are found in Studies I-IV. They are cautiously interpreted or left to the reader to interpret.

Work health factors: organisation, sociodemography, sick-leave, psychological and physical environments including work place aesthetics

Studies I and IV

Cross-sectional studies, addressing the previous 12 months and involving a large working population, all employees at a public-service broadcasting company, were performed to screen for possible health characteristics or determinants. Long-term sick-listed employees were excluded (≥ 6 months).

The expression ‘work health characteristics’ used in Study I served to express determinants for “well-listing” (no sick-listing)^{16,28,171}. There were strong differences between “well-listed” and “not-well-listed” groups and between the 11 occupational groups. The null hypotheses were rejected.

As compared to the concurrent long-term sick-listed reference for stress or musculoskeletal pain in study I, there were no significant differences in working hours (when at work), nor in pain-relatedness to work posture/load (they were not at work), whereas the long-term sick-listed were 2.5 yrs older than the study group and reported more pain and more pain relatedness to stress as well as more medicine intake and computer working hours (when at work). The null hypothesis was rejected.

As compared to Statistics Sweden and the National Social Insurance Board statistics, the study population in Studies I and IV had less sick-leave than the national average^{164,171}. In comparison to an age, gender and professional status adjusted employee sample from Statistics Sweden though, the study population showed more worry about their own health, sleep disturbance, anxiety, neck-shoulder pain, psychologically demanding work, physically demanding work, and experienced more disturbing noise¹⁶⁴.

In the study population the “well-listed” group had more working hours per week and worked more often evenings/weekends than the “not-well-listed” group, a finding contrary to those in some earlier publications^{151,187}. The importance of working hours and their daytime location should not be overestimated in discussions of work health, which tallies with the findings of Beckers et al¹⁸.

“Sickness presenteeism” (being at work in spite of ill-health) was more often reported by the “not-well-listed”, which accords with Aronsson G et al¹⁵. Members of occupational groups providing care or welfare services, or teaching or instructing, run a substantially increased risk of being at work when sick. The present study population with responsibilities for programme production partly resembles “teach and instruct groups”. ‘Working while ill’ was a risk factor for serious coronary events, as reported by Kivimaki et al⁹⁸. The categories with high sickness presenteeism experienced symptoms more often than those without. A common combination was low monthly income, high sickness absenteeism and high sickness

presenteeism. Assuming a connection between high sickness presence and risk to future health, this observation is worth noting for future studies and in formulating preventive targets^{15,16}.

“General living circumstances” was a weak determinant of “well-listing” which contrasts with earlier publications^{25,53,128,133,144}. Neither body mass index nor moderate physical activity were of any relevance for being “well-listed”, while only structured regular training showed significant differences between “well-listed” and “not-well-listed”.

The importance of physical activity at any level, as a health characteristic, is widely accepted^{21,77,170,185}, but this was not confirmed in the present study.

As opposed to some other studies, immigrant background, economic problems, insecure employment status and experience of threat and violence were not related to negative health outcomes^{37,57,99,120,128,197,198}.

The “well-listed” perceived pain, though on a lower intensity than the “not-well-listed” or the long-term-sick-listed reference group. The “well-listed” also scored lower on pain-relatedness to stress and to work posture/load than did the “not-well-listed”. These findings are in line with earlier studies with different perspectives^{111,120,124,139,182}. Note that the self-rated associations between pain and stress emerge already with moderate pain and moderate-term sick-leave. This might indicate that the perceived relatedness to stress is even more important as an early “risk factor” for stress-related ill-health than formerly believed and accords with the findings of worsened stress-biomarkers values as shown in Study II¹⁵⁶.

Support from a superior, influence on work circumstances, less negative work stress and less monotonous work proved to represent health characteristics. This accords with earlier findings^{172,184,187,202}.

Much to do at work, and psychologically strenuous work, were not determinants for not-well-listing, which is in contrast to some earlier studies. Väänänen et al²⁰² identified lack of role clarity, fairness, and good organisational climate as predictors of sickness. The present findings may indicate that the study population was motivated and “adapted” to work. This might also stem from the fact that questions on working hours and employment status came early in the questionnaire, not coupled to the variable ‘set-up’ on health and sickness, and may accordingly have been relatively “objectively” answered.

Between occupational groups, significant differences were found in “well-listing”. Though significant, this was less obvious between educational groups. Educational background and occupational position have been reported earlier as sick-leave predictors^{3,25,127,139,152,178}. Stimulating work, worry about one’s own health, and treatment due to stress did not differ between our occupational groups. Factors differing significantly between occupational groups were e.g. influence on working hours (low for musicians and some others); bent and twisted working positions (common for musicians, cameramen, workroom staff, and picture/sound/light technicians). Research and development technicians showed the lowest frequency of stress-related pain. Musicians trained physically more than others, and were the most well-listed after high executives. Middle-level executives had the most sickness presenteeism at work.

The purpose of the explorative Study IV was to examine the importance of subjective evaluations and therefore the aesthetics^{36,135} and ergonomics were not defined in detail. The decision to leave respondents to judge what was meant by work-place aesthetics^{36,43,45,196} and ergonomics should be considered when interpreting the results. The differences between ‘high

ranking' and 'low ranking' responses to need for *aesthetic* improvements with regard to demographic, work environmental and organisational, and health factors were significant. The relationships to health and disease were fewer and weaker, than subjectively evaluated needs for *ergonomics*, however.

The null-hypothesis of no relation between aesthetic needs and work factors as well as no difference between responses of need for *aesthetic* and *ergonomic* need for improvements were rejected.

Psychologically demanding work and irregular working hours were slightly more articulated for *aesthetics* than for *ergonomics*, whereas sleep disturbances, disturbing noise, pain and pain relatedness to stress and to work posture/load were articulated for both. Psychologically demanding work is earlier shown to be related to work environment and health factors ^{95,111,119,133,139,144,171,178}. The relation of *aesthetics* in the present study to psychologically demanding work might represent an additional work environment factor with possible influence on productivity and health.

Sleep disturbances are shown to be associated to several psychosocial factors, health, demand, control, and emotional support according to Nordin et al 2005 ¹⁴² and Fahlén et al 2006 ⁵². This include adverse consequences for sleep of effort-reward imbalance. Our findings might possibly indicate that sleep disturbances also could be associated with work place *aesthetics*.

Disturbing and high noise level is documented as a risk factor for hearing damage. Danielsson ³⁹ reported disturbing noise as a negative factor in open office environments. In stressful jobs, editorial open surroundings and office landscapes, which are often fore coming in the present study population, the subjectively perceived "ugly" work places may also be noisy.

Stress at work and outside work, and pain factors were associated to both 'high ranking' *aesthetic* and *ergonomic* needs, but this finding was less pronounced for *aesthetics* than for *ergonomics*. The relationship of these se factors to *ergonomics* have been documented earlier ^{111,137,139,153,171,178}. The present results indicate that perceived 'high ranking' need for *aesthetic* improvements might also be related to stress and pain.

'High ranking' respondents regarding both *aesthetic* and *ergonomic* needs for improvement were significantly younger than 'low ranking' participants. The results might point to a higher sensitivity among younger persons to be considered in work health ¹³⁰.

There were no significant gender differences with regard to perceived *aesthetics*, neither to perceived *ergonomic* needs for improvements. Relations with regard to regular physical training was not shown, which activity is considered to support well-being and health according to the literature ^{21,170} and thus could have been expected to increase positive responses. However there is contradictory review documentation this by Hamberg-van Reenen H et al in 2008 ⁶⁵. Our findings seem to be in line with the last mentioned.

Sick-leave, physically demanding work, worry for own health and anxiety were strongly associated to *ergonomic* needs which is in accordance with earlier studies ^{3,67,119,137,139,200}.

The present study group, with persons on long term sick-leave excluded, represents a healthy, normal employee population. Still, differences were found in the studied variables

representing negative occupational health factors between 'high ranking and low ranking' responders to need for *aesthetic* improvements.

The reported need for *aesthetic* and *ergonomic* improvements overlapped only partially. This indicates an independent role of *aesthetic* needs as an important work-environment factor. Specifically this was seen among musicians: nearly 70% of whom reported need for aesthetic improvements, whereas fewer than 25% of them reported need for ergonomic improvements. Similar, though smaller, differences were also reported by other occupational groups. Whether or not the studied population is more sensitive to aesthetics than professional employees in general are, is beyond our judgement. The high ranking by musicians is of interest, though.

In this study, which was a first step in studying work place *aesthetics*, we looked for differences of possible functional relevance. It can be pointed out that for instance psychologically demanding work, pain, stress, sleep disturbances and disturbing noise were significantly correlated to higher aesthetic demands. Those factors' relation to work health is well documented ^{1,39,52,53,119,142,188}.

The present study results indicate a possible impact of work place *aesthetics* on health and well-being. Thus, the inclusion of *work place aesthetics* in work environment improvements and health promotion is an issue to consider.

Stress biomarkers and neck-shoulder-back pain

Study II (for abbreviations see page 11)

This prospective study over a 12 month period on healthy workers was aiming to determine whether associations could be found between stress biomarkers and self rated pain in a normal "white collar" working population with stress and computer intensive work. Previous studies on this issue are rare. Our study null-hypotheses were rejected.

Stress biomarkers versus pain

The results show that individuals in working life with a higher level of regenerative/anabolic activity are less likely to have pain than other subjects, and that decreasing such activity is associated with more pain. Accordingly, the concentration of DHEA-S and endothelin was higher among those without pain than those with pain. Analogously those with decreasing NPY, growth hormone, albumin and HDL concentrations had more pain at follow-up. That NPY is a pain-protective factor, that the general albumin concentration level reflects the general anabolic level, that growth hormone is one of the main anabolic factors and finally that HDL is a factor that protects the vessels against atherosclerosis, agrees with these prospective findings. The predicting power for pain in low levels of DHEA-S, and S-albumin, and in high levels of P-fibrinogen and HbA1c, and with a tendency in the same direction in low S-testosterone values also agrees with the notion that decreasing regenerative/anabolic activity is associated with increasing pain.

It may be surprising that it is not the same factors that appear in the cross-sectional and prospective analyses. However, we have examined a number of factors with differing characteristics, for instance with regard to breakdown and duration. Cross-sectional and prospective analyses are therefore likely to provide different correlates between pain and changes in pain.

The fact that predictive stress biomarkers could be identified in spite of low mean pain levels, and that significant differences in stress biomarkers between “no pain” and “pain” groups were shown, supports the hypothesis that pain- and stress-related catabolic/anabolic activities exist before the pain becomes chronic and limits the daily functions.

Pain, stress and biomarkers

Although very few studies have been published on the relationship between stress biomarkers and moderate pain in working populations, some support for the present results can be found in the literature. Most of the results in previous literature, however, pertain to chronic pain.

Cardiovascular system markers:

BNP has been described by Struthers et al ¹⁶⁵ to be “a simple new test to identify coronary artery disease”. Their findings were made on males. In the present study, the females showed a strongly significant difference between pain and no pain groups in BNP levels with higher BNP in the pain group. A similar difference was not seen in males. According to our knowledge associations between musculoskeletal pain and BNP have not been documented in earlier literature.

Increased **BMI** values, moderate though in the present study, in the “pain” group in males is in accordance with Kaila-Kangas ⁹³ and Evers Larsson ⁵¹ who found a relationship between musculoskeletal pain and high BMI. Also Han TS et al ⁶⁶ found that women with overweight or a high waist-hip ratio have increased likelihood of low back pain. Toda et al ¹⁷⁴ showed that obesity may be a risk factor for chronic low back pain in women. Even a slight increase in BMI might be associated with increased pain prevalence, as seen in the present study.

Stress-related (hypothalamic-pituitary-adrenocortical) HPA-axis, catabolic biomarkers:

Lower **albumin** values are seen in inflammatory and catabolic conditions ⁵⁶. The present study showed decreased albumin values at “pain”. During the time frame between months 6 and 12 (“h6”-“h12”) albumin also increased when pain decreased and vice versa. This finding agrees with decreased albumin values in inflammatory and catabolic conditions. Pain might be considered an inflammation equivalent. Furthermore albumin concentration level is known as a reflector of general anabolic level, which is in accordance with lower DHEA-S, growth hormone, and higher insulin in the “pain” group in the present study.

A well documented and sensitive marker of inflammation and/or any tissue injury is **CRP**. Sturmer et al ¹⁶⁶ found that intensity of pain during the previous 24 hours as assessed by VAS was independently associated with high levels of CRP in patients with acute sciatic pain but not in those with chronic low back pain. CRP was significantly higher in the “pain” group before age and gender adjustments in the current study. This is a finding in accordance with Sturmer et al. **Fibrinogen** is a sensitive indicator of inflammation, an acute phase protein ⁵⁶,

which can be a complement to CRP. Fibrinogen level was significantly higher in the “pain” group in the present study.

ACTH and **cortisol** levels are inter-dependent. They respond to stress⁵⁶ and vary throughout the day. The ACTH is normally highest in the early morning, though it can vary rapidly within a few minutes, and it is at its lowest level in the evening. Cortisol excretion is normally high in the morning and increases during the early morning period, and is reduced in the afternoon and the evening. Only Saliva cortisol 3 concentration in males in the “pain” group was significantly higher than in the “no pain” group. Statistically non-significant associations between “pain” and “no pain” groups in ACTH and Serum-cortisol in the current study may be explained by low mean pain levels.

Regenerative, anabolic stress biomarkers:

It is known from previous studies^{56,70} that sex hormones might be sensitive to stress exposure. **DHEA-S** is found to be related to stress and psychiatric disorders, insulin sensitivity, immunological and cardiovascular disorders according to Kroboth et al¹⁰². Hasson et al⁷⁰ found a possible association between the effects of a web based stress intervention and DHEA-S. In the current study DHEA-S was significantly lower in the “pain” group, and occurred as a predictor of pain at a 12 month follow-up. In the cross-sectional analysis the “pain” group as compared to the “no pain” group showed a significantly lower testosterone level before age and gender adjustments and a tendency after adjustments, whereas no difference was found in estradiol levels. These results are in accordance with Kaergard et al⁹¹ and Wiholm et al [30] who found indications of relations between testosterone level and musculoskeletal pain. They are also in accordance with Hasselhorn and Theorell⁶⁹ who showed that in women with acute onset low back pain a low DHEA-S predicted long-lasting disability due to pain. The findings in DHEA-S and testosterone fit well with the notion that decreasing regenerative/anabolic activity is associated with increasing pain.

A higher **insulin** level in the “pain” group as compared to “no pain” was found. This finding has to our knowledge not been confirmed in earlier literature. It might be related to the changes in **GH** showing a lower level when the pain increased and vice versa in the current study. GH has a circadian variation which increases random error. The excretion increases in recovery and relaxation processes, and decreases with lack of recovery⁵⁶. Leal-Cerro et al¹⁰⁷ found that patients with fibromyalgia exhibited a marked decrease in spontaneous secretion of GH and IGF-I. Bennett et al¹⁹ found lower GH in patients with chronic inflammation in patients with rheumatoid arthritis. The relation to lower DHEA-S in the “pain” group might also be a contributing factor. Our findings support the hypothesis that increasing pain is negatively associated to recovery/anabolic activity and vice versa.

Immune markers and neuropeptides:

NPY has been shown to promote sleep and inhibit ACTH and cortisol release in young men, as well as HPA-axis activity, according to Antonijevic et al⁹. Anderberg⁷ found increased NPY levels in patients with fibromyalgia and long lasting pain. She concluded that long lasting pain may activate NPY anxiolytic and sedative effects. NPY is clearly a marker that can be influenced in both directions by pain. In the longitudinal analyses, the current study

shows a higher NPY level when the pain decreased and vice versa indicating reaction in the NPY system as well in persons with moderate pain levels.

Endothelin is known as one of the most powerful vasoconstrictor substances. In mice with neuropathic pain after chronic constriction injury of the sciatic nerve Klass et al ¹⁰⁰ found that endothelin was a mediator of pain in general. They suggest that their results motivate studies of endothelin as a potential novel therapy for neuropathic pain. Nattero et al 1996 ¹⁴¹ showed that plasma endothelin-1 concentrations decreased during migraine attacks. Endothelin was found to be associated with pain in the present study, as there were lower endothelin levels in the “pain” group as compared to “no pain”. Study results on relations between low endothelin and musculoskeletal pain in healthy working subjects with mild/moderate pain have not been found in the literature.

Work health promotion - prevention on pain and stress

Study III

In this prospective and randomised, controlled intervention study (RCT) with a 12 month follow-up on working population, an evaluation of a web-based stress tool’s impact on pain and pain relatedness to stress, as perceived, in neck, shoulder and back was conducted. Two study groups, one with more intensive intervention, and a control group were included. The groups were standardized for work characteristics and work organization during the study period to avoid confounding factors.

The hypothesis, of a positive impact on pain and pain relatedness to stress in neck, shoulder, upper and low back, was not verified. Some of the sub-results within groups may be of interest, though.

Within groups there was a tendency in the hypothesized direction but this was only for the study group with the less intensive program (group II), and only at the 12 month follow-up (6 months after the end of the intervention period). There was a significant improvement for each gender separately both for pain and pain relatedness to stress in study group II during the same period, from baseline to 12 month follow-up. An unexpected finding was that in the control group there was reportedly a decreased relatedness between pain and stress between baseline and 6 months later. The importance of these within group changes is questionable, since no improvements were seen directly after the intervention period in any of the study groups.

Changes within groups were also seen in body regions. In the study group with the more intensive program (group I), between baseline and 6 month intervention, low back pain had decreased, which was the only difference seen during the intervention period in the group I. In group I, between baseline and 12 month follow-up, improvements were seen in upper back pain relatedness to stress. In both groups, between baseline and 12 month follow-up improvements were seen in neck and low back pain and its relatedness to stress. Moreover shoulder pain was improved in group II. These differences in anatomical subgroups are not consistent, and cannot be interpreted to be of clinical importance in work environment prevention programs.

Fewer significant improvements in pain and pain relatedness to stress were seen in females as compared to males in the group with the more intensive programme. As in earlier studies females had a higher level of pain than males ^{3,23,79,110,139,143}.

Hasson et al ⁷⁰ showed improvements in their group with the more intensive program in stress biomarkers and in stress variables immediately after 6 month intervention as compared to their group with the less intensive program. Our results of the same web-based stress intervention tool - performed simultaneously as their study on the same population - immediately after intervention regarding pain and its relatedness to stress, were not in concordance with their results. Their study group size was larger, they included no untreated control group nor direct questions on pain in neck, shoulder, and back. In their results concerning health predictors as reported in Hasson et al 2006 ⁷², self rated health showed no positive between groups effect neither after 6 month intervention nor 12 months post intervention.

The web-based stress management and health promotion programme is primarily aimed at stress prevention and thus only indirectly at pain prevention. However, in our study not even pain relatedness to stress showed response to the programme.

In multimodal prevention programmes aiming to reduce stress and pain in working life ^{5,81,94,109,117,147,153,194,199} both reduced stress and pain were shown. Similar results were shown in rehabilitation programmes ^{8,13,17,151,159,176,192,195}. The impact on non specific pain and its perceived relatedness to stress in the present study on a working population was not proved. One possible interpretation might be that the login time i.e. the use of the programme was suboptimal. Another interpretation could be that the used intervention programme is suboptimal for identifying and relieving this kind of pain.

Schell et al 2007 (Study II) found that the self reported pain was shown to be directly associated to anabolic and catabolic stress biomarkers in a working population with moderate pain in neck, shoulder and back. Hasson et al ⁷⁰ found that some stress biomarkers, and stress symptoms were positively influenced when the web-based stress management and health promotion programme was used. Analogous results were not verified in the present study regarding neither pain nor pain relatedness to stress.

Future implications

The findings in Study II that the biomarker hormone DHEA-S, as well as HbA1c, albumin and fibrinogen, predict pain in a working population despite only mild/moderate pain, is new. This might in a longer perspective, provided that other studies make the same findings, be a step towards future use of stress biomarker measurements, particularly in non specific pain patients, in pain and stress management.

Another finding which seems to be new is the association of increased BNP concentration with pain, particularly in women, as well as the fact that lower endothelin concentration was associated to pain, which is of interest for future studies.

The causality of these findings – i.e. whether the pain causes deteriorated levels in stress biomarkers' levels or vice versa, and whether pain- and stress-related anabolic/catabolic activities exist before the pain becomes long lasting, intense and limiting of daily functions - needs further investigations. The stress biomarker finding might contribute to increased knowledge of strategies for preventing further progression of neck-shoulder-back pain in persons who are “not yet in chronic pain”.

Since no clear influences on pain and pain relatedness to stress in neck-shoulder-back from a web-based stress-intervention program (Study III) were obtained other methods are needed in health promotion and sickness prevention with regard especially to pain and stress in working populations with high stress and VDU intensive work. The current intervention program was chosen since cost and time-efficient “self-help” tools are of interest. Above that the intervention was an evaluation to see if stress intervention might be sufficient for pain reduction in working life. Since it did not give a satisfactory effect, more design and more deepened multimodal programmes are suggested - work organisation not to forget
30,31,118,121,147,148,173,202

The broad studies of “work health characteristics” (Study I and IV) may serve as a platform for planning tailored health-promotion interventions and studies of causality. The present study findings support that realistic early preventive actions could be executed in today's working life. Since work organisation changes are common in working life - and those are known to be trying and straining - preventive investigations might be cost beneficial on-the-job-productivity.

Empirical research on the role of “aesthetics” in work places and of its impact on productivity is limited (Study IV). Capturing the subjective evaluations of perceived aesthetic needs for improvement and the differences between ‘high ranking’ and ‘low ranking’ groups on work environment and health factors might constitute a base for further studies. The perceived need for “aesthetic” improvements was independent from that for “ergonomic” improvements. The study results indicate that health management may benefit on-the-job-productivity if expanded to target workplace “aesthetics”.

Early prevention actions adapted for working life are suggested according to the present thesis findings.

Conclusions

The overall thesis results encourage to further studies on working life health determinants.

Individuals in working life with a high level of regenerative/anabolic activity are less likely to have pain than other subjects. Decreased regenerative/anabolic activity is associated with increasing pain. The level of NPY, albumin, GH and HDL increases when pain decreases and vice versa. Low DHEA-S predict pain 12 months later. These results might contribute to increased knowledge about strategies to prevent further progression of neck-shoulder-back pain in persons who are “not yet in chronic pain”.

A web-based stress management and health promotion program was not sufficient to influence neck-shoulder-back pain or perceived pain-relatedness to stress in white collar and knowledge workers in stress-intensive occupations, which indicate that not only stress-intervention is sufficient against pain and stress, but broader interventions are needed.

Work health determinants in a large working population were identified. Strong determinants were on one hand *less* “sick-presence at work”, “work-related pain”, “work-related stress”, “sleep disturbances”, “monotonous work”, “bent and twisted work positions” and “disturbing noise”; and on the other hand *more* “perceived good health”, “support superior”, “influence on work performance”, “working irregular hours” and “regular physical training”. “Sociodemography” and “life-style” were of lower importance whereas gender dependence was pronounced with more males well-listed. Differences between occupations were shown.

High ranking need for aesthetic improvements showed associations to more stress, sleep disturbances, problems at work, psychologically demanding work, musculoskeletal pain, and lower age. Gender and physical training did not show difference, whereas occupational status did. The independently tested associations were similar to, but fewer than those for ergonomic needs with regard to: demographics, work environment and health. Sick leave and pain was stronger related to ergonomics.

The response distribution of need for aesthetic improvements was differently distributed from the need for ergonomic improvements? The study results indicate a possible impact of workplace aesthetics on health and well-being. Future work health promotion and prevention may benefit from the inclusion of an assessment of workplace aesthetics.

The thesis results indicate determinants which might be employed to influence future working health intervention and promotion.

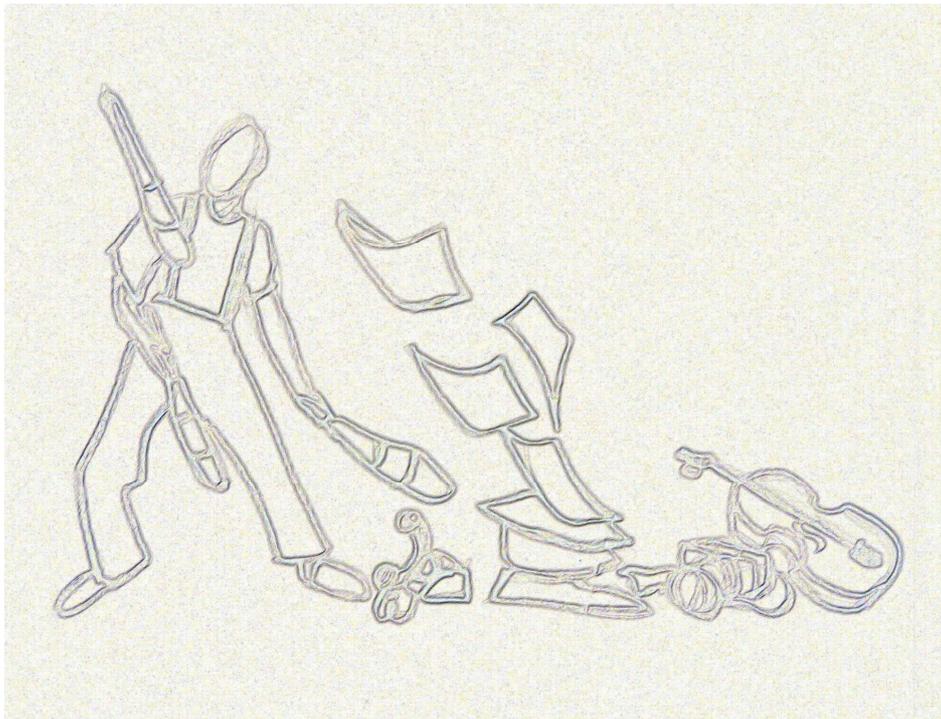
Key words:

aesthetics, biomarkers, ergonomics, health promotion, pain, occupational health, physical training, prevention, psychological and physical demand, rehabilitation, salutogenesis, sick-leave, sociodemography, stress, stress intervention, work ability, work environment, work organisation

SUMMARY OF FINDINGS

The thesis findings identify health determinants from stress biomarkers to work environment which might constitute a base for further studies and influence future work health promotion and intervention.

- Stress biomarker levels in blood tests predicted pain in neck, shoulder and back. Individuals in working life with a high level of anabolic activity and low level of catabolic activity were less likely to have pain than other subjects. Stress biomarker levels changed over time along with changes of pain levels - decreased anabolic activity was associated with increasing pain.
- The new elucidations of stress biomarkers' relation to moderate pain and their predictive value might become of practical use.
- Health determinants as studied between persons with no sick-leave and with any sick-leave (less than six months) were identified in psychological and physiological work environment, organisation, sociodemography, health factors and type of occupation. These findings were partly similar and partly different from those shown in other studies on sick-listing.
- In an age, gender, occupation and time standardized comparison with a national reference sample, the study population of nearly 2000 persons showed more sleep disturbances, neck-shoulder pain, worry and anxiety, and disturbing noise. The sick-absenteeism was lower than the national average, though.
- High perceived need for aesthetic improvements showed associations to more stress, sleep disturbances, problems at work, psychologically demanding work, musculoskeletal pain, and lower age. Gender and physical training did not differ between 'high and low rank' responders, whereas occupational status and age did.
- In news media workers, a web-based health and stress promotion & prevention intervention programme did not reduce pain in neck-shoulder-back nor the perceived pain relatedness to stress.
- Health determinants were in short:
 - strong with regard to *less*: ill-health presenteeism at work, work related pain, work-related stress, sleep disturbances, monotonous work, bent and twisted work positions, and disturbing noise at workplace
 - strong with regard to *more*: perceived good health, support from superior and influence on work and work hours
 - more anabolic and less catabolic stress biomarker activity in persons with no pain in neck-shoulder-back than in those with pain
 - 'high rank' perceived work place aesthetics
 - less pronounced with regard to sociodemography, stress outside work and physical training than in other studies



The juggler by Stina Schell 2008

Äta litet, dricka vatten,
roligt sällskap, sömn om natten,
käckt arbeta, lägligt bo,
stillhet någon stund på dagen
det är lagen
om min hälsa och min ro.

*Olof von Dahlin 1708-1763
(Sweden)*

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REFERENCES

1. Akerstedt T, Knutsson A, Westerholm P, Theorell T, Alfredsson L, Kecklund G. Sleep disturbances, work stress and work hours: a cross-sectional study. *J Psychosom Res.* 2002 Sep;53:741-8.
2. Alderling M, de la Torre B, Forsell Y, Lundberg I, Sondergaard HP, Theorell T. Psychiatric diagnoses and circadian saliva cortisol variations in a Swedish population-based sample (the PART study). *Psychother Psychosom.* 2008;77:129-31. Epub 2008 Jan 25.
3. Alexandersson K, (chairman), 2003, The Swedish Council on Technology Assessment in Health Care. Prescribed sick leave – causes, consequences and physician's certification practice. A systematic literature review. Report No 167, Product-id 167E. (www.sbu.se).
4. Altman D: Practical statistics for medical research (4th ed. London Chapman & Hall) 1994. (cited: Wayne W, Daniel. Biostatistics 1978): A foundation for analysis in the health sciences. John Wiley & Sons, 2nd edition, New York, Chichester, Brisbane, Toronto).
5. Amick B.C 3rd, Robertson M M, De Rango K, Bazzani L, Moore A, Rooney T, Harrist R. Effect of office ergonomics intervention on reducing musculoskeletal symptoms. *Spine* 2003;28:2706-11.
7. Anderberg UM, Liu Z, Berglund L, Nyberg F. Elevated plasma levels of neuropeptide Y in female fibromyalgia patients. *Eur J Pain* 3 1999;1:19-30.
8. Anema, JR, Cuelenaere B, van der Beek, AJ, Knol DL, de Vet HC, van Mechelen W. The effectiveness of ergonomic interventions on return-to-work after low back pain; a prospective two year cohort study in six countries on low back pain patients sick-listed for 3-4 months. *Occupational and Environment Medicine* 2004;61:289-94.
9. Antonijevic IA, Murck H, Frieboes RM, Barthelmes J, Steiger A Sexually dimorphic effects of GHRH on sleep-endocrine activity in patients with depression and normal controls - part I: the sleep eeg. *Sleep Res Online.* 2000;3 :5-13.
10. Antonovsky A. The salutogenic model as a theory to guide health promotion. *Health promotion International* 1996;11:11-8.
11. Ariëns GA, Bongers PM, Hoogendoorn WE, Houtman IL, van der Wal G, van Mechelen W. High quantitative job demands and low coworker support as risk factors for neck pain: results of a prospective cohort study. *Spine.* 2001 Sep 1;26:1896-901; discussion 1902-3.
12. Arnetz BB. Technological stress: psychophysiological aspects of working with modern information technology. *Scand J Work Environ Health.* 1997;23 Suppl 3:97-103.
13. Arnetz BB, Sjogren B, Rydén B, Meisel R. Early workplace intervention for employees with musculoskeletal-related absenteeism: a prospective controlled intervention study. *Journal Occupational Environmental Medicine* 2003; 45:499-506.
14. Arnetz BB, Wiholm C. Technological stress: psychophysiological symptoms in modern offices. *J Psychosom Res.*1997;43:35-42.
15. Aronsson G. Scand Influence of worklife on public health. *J Work Environ Health* 1999; 25:597-604.

16. Aronsson G, Gustafsson K, Dallner M. Sick but yet at work. An empirical study of sickness presenteeism. *J Epidemiol Community Health* 2000;54:502-9.
17. Asenlof P, Denison E, Lindberg P. Individually tailored treatment targeting activity, motor behaviour, and cognition reduces pain-related disability: a randomized controlled trial in patients with musculoskeletal pain. *J Pain* 2005;6:588-603.
18. Beckers DG, van der Linden D, Smulders PG, Kompier MA, van Veldhoven MJ, van Yperen NW. Working overtime hours: relations with fatigue, work motivation, and the quality of work. *J Occup Environ Med* 2004; 46:1282-9.
19. Bennett R. Growth hormone in musculoskeletal pain states. *Curr Rheumatol Rep.* 2004;6:266-73.
20. Bergström G, Jensen IB, Bodin L, Linton SJ, Nygren AL, Carlsson SG. Reliability and factor structure of the Multidimensional Pain Inventory--Swedish Language Version (MPI-S). *Pain.* 1998 Mar;75:101-10.
21. Bernaards CM, Jans MP, van den Heuvel SG, Hendriksen IJ, Houtman IL, Bongers PM. Can strenuous leisure time physical activity prevent psychological complaints in a working population? *Occup Environ Med* 2006;63:10-6.
22. Bernin P, Theorell T, Sandberg CG. Biological correlates of social support and pressure at work in managers. *Integr Physiol Behav Sci* 2001;36:121-36.
23. Bingefors K, Isaksson D. Epidemiology, co-morbidity, and impact on health-related quality of life of self-reported headache and musculoskeletal pain – a gender perspective. *Eur J Pain* 2004; 8:435-50.
24. Björntorp P. Do stress reactions cause abdominal obesity and comorbidities? *Obes Rev.* 2001 May;2:73-86.
25. Blank N, Diderichsen F. Short-term and long-term sick-leave in Sweden: relationships with social circumstances, working conditions and gender. *Scand J Soc Med* 1995;23:265-72.
26. Blom G: Probability and statistics: theory and applications. Springer text in Statistics) Hardcover, Springer, 1989 07-21, 0387968520 / 0-387-96852-0.
27. Bongers PM, de Winter CR, Kompier MA, Hildebrandt VH. Psychosocial factors at work and musculoskeletal disease. *Scand J Work Environ Health.* 1993 Oct;19:297-312.
28. Bongers PM, Ijmker S, van den Heuvel S, Blatter BM. Epidemiology of work related neck and upper limb problems: psychosocial and personal risk factors (part I) and effective interventions from a bio behavioural perspective (part II). *J Occup Rehabil.* 2006 Sep;16: :279-302.
29. Bongers PM, Kremer AM, ter Laak J. Are psychosocial factors, risk factors for symptoms and signs of the shoulder, elbow, or hand/wrist?: A review of the epidemiological literature. *AmJ Ind Med.* 2002 May;41:315-42
30. Bongers PM, de Vet HC, Blatter BM. Repetitive strain injury (RSI): occurrence, etiology, therapy and prevention. *Ned Tijdschr Geneesk.* 2002 Oct 19;146:1971-6.
31. Bongers PM. Why is the information on cost effectiveness of interventions to manage neck and upper limb symptoms still lacking, while all stakeholders would benefit from this information? *Occup Environ Med.* 2007 May;64:289-90.

32. Brady R. The use of stress management techniques with depression. *The Science and Engineering* 1995;58:3580.
33. Breslow N E, Day N E. *Statistical methods in cancer research. Volyme 1 - The analyses of case control studies.* IARC scientific publications No 32, 1980. ISBN 92 832 01 329.
34. Carayon P, MJ Smith. Work organization, job stress, and work-related musculoskeletal disorders. *Hum Factors* 1999;41:644-63.
35. Caspari S, Eriksson K, Nåden D. The aesthetic dimension in hospitals - an investigation into strategic plans. *J Nurs Stud* 2006;43:851-9.
36. Caspari S, Nåden D, Eriksson K. Why not ask the patient? An evaluation of the aesthetic surroundings in hospitals by patients. *Qual Manag Health Care* 2007;16:280-92.
37. D'Souza RM, Strazdins L, Lim LL-Y et al. Work and health in a contemporary society: demands, control, and insecurity. *J Epidemiol Community Health* 2003;57:849-54.
38. Dane D, Feuerstein M, Huang GD, Dimberg L, Ali D, Lincoln A. Measurement properties of a self-report index of ergonomic exposures for use in an office work environment. *Journal of Occupational and Environment Medicine* 2002;44:73-8.
39. Danielsson K. *Office Environment, Health & Job Satisfaction: An explorative study of Office Design's Influence.* Licentiate thesis in Technology and Health. Stockholm, Sweden 2005. Article in: *Licentiate thesis in Technology and Health.* Stockholm, Sweden, ISBN:91-7178-168-4.
40. de Lange AH, Taris TW, Kompier MA, Houtman IL, Bongers PM Effects of stable and changing demand-control histories on worker health. *Scand J Work Environ Health.* 2002 Apr;28:94-108.
41. de Lange AH, Taris TW, Kompier MA, Houtman IL, Bongers PM."The very best of the millennium": longitudinal research and the demand-control-(support) model. *J Occup Health Psychol.* 2003 Oct;8:282-305.
42. de Lange AH, Taris TW, Kompier MA, Houtman IL, Bongers PM. Different mechanisms to explain the reversed effects of mental health on work characteristics. *Scand J Work Environ Health.* 2005 Feb;31:3-14.
43. Dekker SW, Nyce JM. How can ergonomics influence design? Moving from research findings to future systems. *Ergonomics* 2004;47:1624-39
44. Dilani A. Psychosocially supportive design-Scandinavian health care design. *World Hospital and Health Service* 2001;37:20-4, 33-35.
45. Dilani A. Healthcare buildings as supportive environments. *World Hospital and Health Service* 2000;36:20-6.
46. Dilani A. A new paradigm of design and health in hospital planning. *World Hosp Health Serv* 2005;41:17-21.
47. Ekman R, Arnetz BB. *Stress, molekylerna, individen, organisationen, samhället.* 2002 Stockholm. Liber.
48. ENWHP *The Luxembourg Declaration on Workplace Health Promotion in the European Union : European Network for workplace health promotion, 1997.*

49. Estlander AM, Takala EP, Viikari-Juntura E. Do psychological factors predict changes in musculoskeletal pain? A prospective, two-year follow-up study of a working population. *J Occup Environ Med.* 1998; 40:445-53.
50. European Union 2005; EU 27: European Agency for Safety and Health at Work www.eu.se.
51. Evers Larsson U. Influence of weight loss on pain, perceived disability and observed functional limitations in obese women. *International Journal of Obesity.* 2004; 28:269-277.
52. Fahlén G, Knutsson A, Peter R, Akerstedt T, Nordin M, Alfredsson L, Westerholm P. Effort-reward imbalance, sleep disturbances and fatigue. *Int Arch Occup Environ Health* 2006;79:371-8.
53. Feyer AM, Herbison P, Williamson AM, de Silva I, Mandryk J, Hendrie L, Hely MC. The role of physical and psychological factors in occupational low back pain: a prospective cohort study. *Occupational and Environment Medicine* 2000;57:116-20.
54. Fransson E, Knutsson A, Westerholm P, Alfredsson L. Indications of recall bias found in a retrospective study of physical activity and myocardial infarction. *J Clin Epidemiol.* 2008 Aug;61:840-7. Epub 2008 Mar 21.
55. Fredriksson K, Alfredsson L, Ahlberg G, Josephson M, Kilbom A, Wigaeus Hjelm E, Wiktorin C, Vingård E; MUSIC/Norrtaälje Study Group. Musculoskeletal Intervention Centre. Work environment and neck and shoulder pain: the influence of exposure time. Results from a population based case-control study. *Occup Environ Med.* 2002 Mar;59:182-8.
56. Ganroth PO, Grubb A, Stenflo J. *Clinical Chemistry, 1997* (in Swedish:Klinisk Kemi). ISBN 91-4400490-7, Studentlitteratur. <http://www.studli.se>.
57. Gimeno D, Benavides FG, Amick BC 3rd, Benach J, Martínez JM. Psychosocial factors and work related sickness absence among permanent and non-permanent employees. *J Epidemiol Community Health.* 2004;58:870-6.
58. Goldstein DS, McEwen B. Allostasis, homeostats, and the nature of stress. *Stress.* 2002 Feb;5:55-8.
59. Griep EN, Boersma JW, Lentjes EG, Prins AP, van der Korst JK, de Kloet ER (1998). Function of the hypothalamic-pituitary-adrenal axis in patients with fibromyalgia and low back pain. *J Rheumatol* 1998;25:1374-81.
60. Grooten WJ; MUSIC Norrtaälje Study Group. Predictors for persistent neck/shoulder pain, medical care-seeking due to neck/shoulder pain and sickness absence. *Clin. Rehabil.* 1997 Jul; 21:648-59.
61. Grossi G, Perski A, Ekstedt M, Johansson T, Lindström M, Holm K. The morning salivary cortisol response in burnout. *J Psychosom Res.* 2005 Aug; 59:103-11.
62. Grossi G, Theorell T, Jürisoo M, Setterlind S. Psychophysiological correlates of organizational change and threat of unemployment among police inspectors. *Integr Physiol Behav Sci.* 1999 Jan-Mar;34:30-42.
63. Hagberg M, Vilhemsson R, Tornqvist EW, Toomingas A. Incidence of self-reported reduced productivity owing to musculoskeletal symptoms: association with workplace and individual factors among computer users. *Ergonomics.* 2007 Nov;50:1820-34.
64. Hasson D. *Stress Management Interventions and Predictors of Long-term Health.* Thesis Uppsala University, Sweden 2005. ISBN 91-554-6350-9

65. Hamberg-van Reenen HH, Ariëns GA, Blatter BM, van Mechelen W, Bongers PM. A systematic review of the relation between physical capacity and future low back and neck/shoulder pain. *Pain* 2008;130:93-107.
66. Han TS, Schouten JS, Lean ME, Seidell JC. The prevalence of low back pain and associations with body fatness, fat distribution and height. *Int J Obes Relat Metab Disord* 1997;21:600-7.
67. Hansson T, Jensen I. Swedish Council on Technology Assessment in Health Care (SBU). Chapter 6. Sickness absence due to back and neck disorders. *Scand J Public Health Suppl* 2004;63:109-51.
68. Harkness EF, Macfarlane GJ, Nahit E, Silman AJ, McBeth J. Mechanical injury and psychosocial factors in the work place predict the onset of widespread body pain: a two-year prospective study among cohorts of newly employed workers. *Arthritis Rheumatology* 2004;50:1655-64.
69. Hasselhorn HM, Theorell T, Vingard E. Musculoskeletal Intervention Center (MUSIC)-Norrtälje Study Group. Endocrine and immunologic parameters indicative of 6-month prognosis after the onset of low back pain or neck/shoulder pain. *Spine* 2001;26: E24-9.
70. Hasson D, Anderberg UM, Theorell T, Arnetz BB Psychophysiological effects of a web-based stress management system: A prospective, randomized controlled intervention study of IT and media workers. 2005; *BMC Public Health*, doi:10.1186/1471-2458-5-78 5:78.
71. Hasson D, Arnetz B, Jelveus L, Edelstam B. A randomized clinical trial of the treatment effect of massage compared to relaxation tape recording on diffuse long-term pain. *Psychother Psychosom.* 2004 Jan-Feb; 73:17-24.
72. Hasson D, Arnetz BB, Theorell T, Anderberg UM. Predictors of self-rated health: a 12-month prospective study of IT and media workers. *Popul Health Metr.* 2006 Jul 31;4:8.
73. Heinrich J, Blatter BM, Bongers PM. A comparison of methods for the assessment of postural load and duration of computer use. *Occupational and Environment Medicine* 2004;61:1027-31.
74. Helander M. Forget about ergonomics in chair design? Focus on aesthetics and comfort! *Ergonomics* 2003;Oct 20-Nov 15;46:1306-19.
75. Hertting A, Nilsson K, Theorell T, Larsson US. Downsizing and reorganization: demands, challenges and ambiguity for registered nurses. *J Adv Nurs.* 2004 Jan;45:145-54.
76. Hess D. Employee perceived stress. Relationship to the development of repetitive strain injury symptoms. *AAOHN Journal* 1997;45:115-23.
77. Hildebrandt VH, Bongers PM, Dul J, van Dijk FJ, Kemper HC. The relationship between leisure time, physical activities and musculoskeletal symptoms and disability in worker populations. *Int Arch Occup Environ Health.* 2000 Nov;73:507-18.
78. Hogg-Johnson S, van der Velde G, Carroll LJ, Holm LW, Cassidy JD, Guzman J, Côté P, Haldeman S, Ammendolia C, Carragee E, Hurwitz E, Nordin M, Peloso P; Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. The burden and determinants of neck pain in the general population: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine.* 2008 Feb 15;33(4 Suppl):S39-51.

79. Hooftman WE, van der Beek AJ, Bongers PM, van Mechelen W. Gender differences in self-reported physical and psychosocial exposures in jobs with both female and male workers. *J Occup Environ Med.* 2005 Mar;47:244-52.
- 80.. Hoogendoorn WE, van Poppel MN, Bongers PM, Koes BW, Bouter LM. Systematic review of psychosocial factors at work and private life as risk factors for back pain. *Spine.*2000 Aug 15;25:2114-25.
81. Horneij E, Hemborg B, Jensen I, Ekdahl C. No significant differences between intervention programmes on neck, shoulder and low back pain: a prospective randomized study among home-care personnel. *J Rehabil Med* 2001;33:170-6.
82. Houtman IL, Bongers PM, Smulders PG, Kompier MA. Psychosocial stressors at work and musculoskeletal problems. *Scand J Work Environ Health.*1994 Apr;20:139-46.
83. Huang GD, Feuerstein M. Identifying work organization targets for a work-related musculoskeletal symptom prevention program. *Journal of Occupational Rehabilitation* 2004;14:13-30.
84. Ihlebaek C, Hansson TH, Laerum E, Brage S, Eriksen HR, Holm SH, Svendsrød R, Indahl A. Prevalence of low back pain and sickness absence: a "borderline" study in Norway and Sweden. *Scand J Public Health.* 2006;34:555-8.
85. IJmker S, Blatter BM, van der Beek AJ, van Mechelen W, Bongers PM. Prospective research on musculoskeletal disorders in office workers (PROMO): study protocol. *BMC Musculoskelet Disord.* 2006 Jul 5;7:55.
86. IJmker S, Leijssen JN, Blatter BM, van der Beek AJ, van Mechelen W, Bongers PM. Test-retest reliability and validity of self-reported duration of computer use at work. *Scand J Work Environ Health.*2008 Apr;34:113-9. Epub 2008 May 12.
87. IJmker S, Mikkers J, Blatter BM, van der Beek AJ, van Mechelen W, Bongers PM. Test-retest reliability and concurrent validity of a web-based questionnaire measuring workstation and individual correlates of work postures during computer work. *Appl Ergon.* 2008 Nov;39:685-96. Epub 2008 Feb 4.
88. Johansson JA, Rubenowitz S. Risk indicators in the psychosocial and physical work environment for work-related neck, shoulder and low back symptoms: a study among blue- and white-collar workers in eight companies. *Scand J Rehabil Med.*1994 Sep;26:131-42.
89. Johansson JA, Rubenowitz S. Risk indicators in the psychosocial and physical work environment for work-related neck, shoulder and low back symptoms: a study among blue- and white-collar workers in eight companies. *Scand J Rehabil Med.* 1994 Sep;26:131-42.
90. Kadefors R, Melin B, Palmerud G, Hassmen P, Engstrom M, Dohns IE. Psychological stress and EMG activity of the trapezius muscle. *Int J Behav Med* 1994;1:354-70.
91. Kaergaard A, Hansen AM, Rasmussen K, Andersen JH (2000) Associations between plasma testosterone and work related neck and shoulder disorders among female workers. *Scand J Work Environ Health* 2000; 26:292-98.
92. Kagan AR, Levi L. Health and environment--psychosocial stimuli: a review. *Soc Sci Med.* 1974 May;8:225-41.

93. Kaila-Kangas L, Leino-Arjas P, Riihimäki H, Luukkonen R, Kirjonen J (2003) Smoking and Overweight as Predictors of Hospitalization for Back Disorders. *Spine* 28:1860-1868.
94. Kaplansky BD, Wei FY, Reecer MV. Prevention strategies for occupational low back pain. *Occup Med.* 1998 Jan-Mar;13:33-45.
95. Karasek R, Theorell T. *Healthy work. Stress productivity, and the reconstruction of working life*, 1990. (New York, Basic books, inc.)
96. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. *J Occup Health Psychol.* 1998 Oct;3:322-55.
97. Karlqvist LK, Härenstam A, Leijon O, Schéele P; MOA Research Group. Excessive physical demands in modern worklife and characteristics of work and living conditions of persons at risk. *Scand J Work Environ Health.* 2003 Oct; 29:363-77.
98. Kivimäki M, Head J, Ferrie JE, Hemingway H, Shipley MJ, Vahtera J, Marmot MG. Working while ill as a risk factor for serious coronary events: the Whitehall II study. *Am J Public Health* 2005;95:98-102.
99. Kivimäki M, Vahtera J, Thomson L, Griffiths A, Cox T, Pentti J. Psychosocial factors predicting employee sickness absence during economic decline. *Appl Psychol* 1997; 82:858-72.
100. Klass M, Hord A, Wilcox M, Denson D, Csete M (2005) A role for endothelin in neuropathic pain after chronic constriction injury of the sciatic nerve. *Anesth Analg.* 2005;101:1757-62.
101. Korhonen T, Ketola R, Toivonen R, Luukkonen R, Hakkanen M, Viikari-Juntura E, Estlander AM, Takala EP. Work related and individual predictors for incident neck pain among office employees working with video display units. *Occup Environ Med* 2003; 60:475-82.
102. Kroboth PD, Salek FS, Pittenger AL, Fabian TJ, Frye RF (1999) DHEA and DHEA-S: a review. *J Clin Pharmacol.* 1999;39:327-48.
103. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sorensen F, Andersson G, Jorgensen K. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics* 1987;18:233-237.
104. Lavis JN, Mustard CA, Payne JI, Farrant MS. Work-related population health indicators. *Can J Public Health.* 2001 Jan-Feb;92:72-8.
105. Lazarus RS, Folkman S. *Stress, appraisal, and coping.* 1984 New York Springer.
106. Lazarus RS. Toward better research on stress and coping. *Am Psychol.* 2000 Jun;55:665-73.
107. Leal-Cerro A, Povedano J, Astorga R, Gonzalez M, Silva H, Garcia-Pesquera F, Casanueva FF, Dieguez C. The growth hormone (GH)-releasing hormone-GH-insulin-like growth factor-1 axis in patients with fibromyalgia syndrome. *J Clin Endocrinol Metab.* 1999; 84:3378-81.
108. Leather P, Pyrgas M, Beale D & Lawrence C. Windows in the workplace: Sunlight, view, and occupational stress. *Environment and Behaviour* 1998;30:739-762.

109. Leijon O, Harenstam A, Waldenström K, Alderling M, Vingard E. Target groups for prevention of neck/shoulder and low back disorders: an exploratory cluster analysis of working and living conditions. *Work* 2006;27:189-204.
110. Leijon O. Exposure assessment. gender and context, and target groups for prevention of neck/shoulder and low back pain. Thesis for doctoral degree 2006. Karolinska Institutet. ISBN 91-7140-616-6.
111. Leroux I, Dionne CE, Bourbonnais R. Psychosocial job factors and the one-year evolution of back-related functional limitations. *Scandinavian Journal of Work Environment Health* 2004;30:47-55.
112. Levi L. The stress of every day work as reflected in productiveness subjective feelings and urinary output of adrenaline and nor-adrenaline under salaried and piece work conditions. *J Psychosom Res.*1964 Dec;8:199-202.
113. Levi L, Bartley M, Marmot M, Karasek R, Theorell T, Siegrist J, Peter R, Belkić K, Savić C, Schnall P, Landsbergis P. Stressors at the workplace: theoretical models. *Occup Med.* 2000 Jan-Mar;15: 69-106.
114. Levi L, Sauter SL, Shimomitsu T. Work-related stress--it's time to act. *J Occup Health Psychol.* 1999 Oct;4:394-6.
115. Likert R. A technique for the development of attitudes scales. *Educational and Psychological measurements* 1952;12:313-15.
116. Lindberg P, Vingård E, Josephson M, Alfredsson L. Retaining the ability to work-associated factors at work. *Eur J Public Health* 2006;16:470-5.
117. Lindberg P, Josephson M, Alfredsson L, Vingård E. Promoting excellent work ability and preventing poor work ability: the same determinants? Results from the Swedish HAKuL study. *Occup Environ Med*;2006 63:113-20.
118. Lindberg, P. The work ability continuum. Epidemiological studies of factors promoting sustainable work ability. Thesis for doctoral degree, 2006; Dep of Clinical Neuroscience, Section of Personal Injury Prevention, Karolinska Intitutet, SE-17177 Stockholm, Sweden,
119. Linton SJ. A review of psychological risk factors in back and neck pain. *Spine* 2000; 25:1148-56.
120. Linton SJ. The socioeconomic impact of chronic back pain: is anyone benefiting? *Pain.* 1998 Apr;75: 63-8.
121. Linton SJ. Occupational psychological factors increase the risk for back pain: a systematic review.*J Occup Rehabil.* 2001 Mar;11:53-66. Review.
122. Linton SJ. Do psychological factors increase the risk for back pain in the general population in both a cross-sectional and prospective analysis? *Eur J Pain.* 2005 Aug;9:355-61.
123. Linton SJ, van Tulder MW. Preventive interventions for back and neck pain problems: what is the evidence? *Spine.* 2001 Apr 1;26:778-87. Review.
124. Lowe GS, Schellenberg, G, Shannon HS. Correlates of employees' perceptions of a healthy work environment. *American Journal of Health Promotion* 2003;17:390-9.

125. Lundberg U. Psychophysiology of work: stress, gender, endocrine response, and work-related upper extremity disorders. *Am J Ind Med* 2002;41:383-92.
126. Lundberg U, Dohns IE, Melin B, Sandsjo L, Palmerud G, Kadefors R, Ekstrom M, Parr D Psychophysiological Stress Responses, Muscle Tension, and Neck and Shoulder Pain Among Supermarket Cashiers. *Journal of Occupational Health Psychology*. 1999; 4:245-255.
127. Marmot M, Feeney A, Shipley M, North F, Syme SL. Sickness absence as a measure of health status and functioning: from the UK Whitehall II study. *J Epidemiol Community Health* 1995;49:124-30.
128. Martikainen P, Adda J, Ferrie JE, Davey Smith G, Marmot M. Effects of income and wealth on GHQ depression and poor self rated health in white collar women and men in the Whitehall II study. *J Epidemiol Community Health* 2003;57:718-23.
129. Maslow AH, & Mintz N L. Effects of aesthetic surroundings: Initial short-term effects of three aesthetic conditions upon perceiving “energy” and “well-being” in faces. In:Gutman (Ed.), *People and buildings* (pp. 212-219) 1972; New York: Basic Books.
130. May DR, Reed K, Schroeder CE, Potter P. Ergonomic office design and aging: a quasi-experimental field study of employee reactions to an ergonomics intervention program, *Journal of Occupational Health Psychology* 2004;9:123-35.
131. McCormack HM, Horne DJ, Sheather S: Clinical application of visual analogue scales: a critical review: *Psychol Med* 1988;18:1007-1019.
132. McEwans b. s. Plasticity of the hippocampus: adaptation to chronic stress allostatic load. *Ann N Y Acad Sci* 2001;933:265-77.
133. Melchior M, Krieger N, Kawachi I, Berkman LF, Niedhammer I, Goldberg M. Work factors and occupational class disparities in sickness absence: findings from the GAZEL cohort study. *Am J Public Health* 2005;95:1206-12.
134. Melin B, Lundberg U. A biopsychosocial approach to work-stress and musculoskeletal disorders. *Journal of Psychophysiology* 1997;11:238-247.
135. Mintz NL. Effects of aesthetic surroundings: 2. Prolonged and repeated experience in a “beautiful” and an “ugly” room. In Gutman R (Ed.), *People and buildings* 1972; (pp. 220-228). New York: Basic Books´.
136. Murphy L R. Stress management in work settings: a critical review of the health effects. *Am Journal Health promotion* 1996;11:112-35.
137. Music S, Hook D, Banner S, Spooner M, Erdington DEW. The association of corporate work environment factors, health risks, and medical conditions with presenters among Australian employees. *Am* 2006; 21:127-36.
138. Myrianthefs P, Karatza S, Venetsanou K, Grouzi E, Evagelopoulou P, Boutzouka E, Fildissis G, Spiliotopoulou I, Baltopoulos G. Seasonal variation in whole blood system. *Cytokine* 2003;24:286-92.
139. Nachemsson A (chairman). The Swedish Council on Technology Assessment in Health Care. Neck and Back pain. A systematic review 2000; Report No 145, Product-id 145E, (www.sbu.se).

141. Nattero G, Mengozzi G, Inconis T, Paradisi L. Nitric oxide, endothelin-1, and transcranial Doppler in migraine. Findings in interictal conditions and during migraine attack. *Headache* 1996; 36:307-11.
142. Nordin M, Knutsson A, Sundbom E, Stegmayr B. Psychosocial factors, gender, and sleep. *J Occup Health Psychol* 2005;10:54-63.
143. Norman K, Nilsson T, Hagberg M, Tornqvist EW, Toomingas A. Working conditions and health among female and male employees at a call centre in Sweden. *American Journal Industrial Medicine* 2004;46:55-62.
144. North F, Syme SL, Feeney A, Head J, Shipley MJ, Marmot MG. Explaining socioeconomic differences in sickness absence: the Whitehall II Study. *BMJ*. 1993;6;306(6874):361-6.
145. O'Donnell M. *American Journal of Health Promotion* 1989;3:5.
146. Ong L, Linden W, Young S. Stress management: what is it? *J Psychosom Res.* 2004 Jan;56:133-7.
147. Ostry AS, Kelly S, Demers PA, Mustard C, Hertzman C. A comparison between the effort-reward imbalance and demand control models. *BMC Public Health.* 2003 Feb 27;3:10. Epub 2003;Feb 27.
148. Ostry AS, Marion SA, Demers PA, Hershler R, Kelly S, Teschke K, Mustard C, Hertzman C. Comparison of expert-rater methods for assessing psychosocial job strain. *Scand J Work Environ Health.* 2001 Feb;27:70-5.
149. Parker SK, Chmiel N, Wall TD. Work characteristics and employee well-being within a context of strategic downsizing. *J Occup Health Psychol* 1997;2:289-303.
150. Pawlow LA, Jones GE. The impact of abbreviated progressive muscle relaxation on salivary cortisol and salivary immunoglobulin A (sIgA). *Appl Psychophysiol Biofeedback.* 2005 Dec;30:375-87.
151. Perski A, Grossi G. [Treatment of patients on long-term sick leave because of stress-related problems. Results from an intervention study] *Lakartidningen.* 2004 Apr 1;101:1295-8. [Article in Swedish]
152. Piirainen H, Räsänen K, Kivimäki M1: Organizational climate, perceived work-related symptoms and sickness absence: a population-based survey. *J Occup Environ Med* 2003; 45:175-84.
153. Robertson MM, O'Neill MY. Reducing musculoskeletal discomfort: effects of an office ergonomics workplace and training intervention. *International Journal of Occupational Safety and Ergonomics* 2003;9:491-502.
154. Rugulies R, Braff J, Frank JW, Aust B, Gillen M, Yen IH, Bhatia R, Ames G, Gordon DR, Janowitz I, Oman D, Jacobs BP, Blanc P. The psychosocial work environment and musculoskeletal disorders: design of a comprehensive interviewer-administered questionnaire. *American Journal of Industrial Medicine* 2004;45:428-39.
155. Sandlund A, Matha P. Karolinska University Hospital Laboratory 2006; years 2002-2003 [http://www.karolinska.se/templates/Division Start 45656.aspx](http://www.karolinska.se/templates/Division%20Start%2045656.aspx).

156. Schell E, Theorell T, Hasson D, Arnetz B, Saraste H. Stress biomarkers' associations to pain in the neck, shoulder and back in healthy media workers: 12-month prospective follow-up. *Eur Spine J*. 2008 Mar;17:393-405. Epub 2007 Dec 13.
159. Schultz D. The Effectiveness of stress management on anxiety and depression. *The Sciences and Engineering* 2002;23:1040.
160. Selye H. A syndrome produced by diverse nocuous agents. 1936. *J Neuropsychiatry Clin Neurosci*. 1998 Spring;10:230-1.
161. Selye H. Stress and the reduction of distress. *J S C Med Assoc*. 1979 Nov;75:562-6. No abstract available.
162. Severens JL, Mulder J, Laheij RJ, Verbeek AL. Precision and accuracy in measuring absence from work as a basis for calculating productivity costs in The Netherlands. *Soc Sci Med* 2000;51:243-9.
163. Siegrist J. Adverse health effects of high-effort/low-reward conditions. *J Occup Health Psychol*. 1996 Jan;1:27-41.
164. Statistics Sweden: ¹⁾ Living Conditions Survey: report No 95, No 97 (2002-2004 in Swedish) ²⁾ Living Condition Survey ('ULF'=undersökning om levnadsförhållanden 2002, in Swedish). Personal direct collaboration 2008 for a matched reference group ³⁾ Work Force Survey (AKU=arbetskraftsundersökning 2008, in Swedish) www.scb.se
165. Struthers AD, Davies J. B-type natriuretic peptide: a simple new test to identify coronary artery disease? *QJM* 2005; 98:765-9.
166. Sturmer T, Raum E, Buchner M, Gebhardt K, Schiltenswolf M, Richter W, Brenner H (2005) Pain and high sensitivity C reactive protein in patients with chronic low back pain and acute sciatic pain. *Ann Rheum Dis*. 2005;64:921-5.
167. Sullivan M J, Feuerstein M, Gatchel R, Linton SJ, Pransky G. Integrating psychosocial and behavioural interventions to achieve optimal rehabilitation outcomes. *J Occup Rehabil* 2005; 15:475-89. ☐
168. Sullivan M, Karlsson J. The Swedish SF-36 Survey III. Evaluation of Criterion-Based Validity: Resultat from Normal population. *Journal of clinica epidemiology* 1998;51:110513
170. The National Institute of Public Health, 2008, (Statens Folkhälsoinstitut, in Swedish), Olof Palmes gata 17, SE-103 52 Stockholm, Tfn/Phone + 46 (0)8 566 135 00. www.fhi.se
171. The national Social Insurance in Sweden, 2008, <http://www.forsakringskassan.se>
172. Theorell T. Possible mechanisms behind the relationship between demand-control-support model and disorders of the locomotor system. London 1996; Taylor & Frances, p. 65-73.
173. Theorell T, Nordemar R, Michelsen H. Pain thresholds during standardized psychological stress in relation to perceived psychosocial work situation. Stockholm Music I Study Group. *J Psychosom Res* 1993; 37:299-305.
174. Toda Y, Segal N, Toda T, Morimoto T, Ogawa R.. Lean body mass and body fat distribution in participants with chronic low back pain. *Arch Intern Med*. 2000;27:3265-9.

175. Tornqvist EW, Kilbom A, Vingård E, Alfredsson L, Hagberg M, Theorell T, Waldenström M, Wiktorin C, Hogstedt C; MUSIC-Norrtälje Study Group. The influence on seeking care because of neck and shoulder disorders from work-related exposures. *Epidemiology*. 2001 Sep;12:537-45.
176. Tritilanunt T, Wajanavisit W. The efficacy of an aerobic exercise and health education program for treatment of chronic low back pain. *J Med Assoc Thai*. 2001;84 Suppl 2:S528-33.
178. Tuomi K, Ilmarinen J, Eskelinen L, Järvinen E, Toikkanen J, Klockars M. Prevalence and incidence rates of diseases and work ability in different work categories of municipal occupations. *Scand J Work Environ Health* 1991;17 Suppl 1:67-74.
179. Ulrich S R Effects of interior design on wellness: theory and recent scientific research. *J Health Care Inter Des*.1991;3:97-109.
180. Wahlstrom J, Lindgard A, Ahlberg G Jr, Ekman A, Hagberg M. Perceived muscular tension, emotional stress, psychological demands and physical load during VDU work. *Int Arch Occup Environ Health* 2003;76:584-90. Epub 2003 Jul 24.
181. Wahlstrom J. Ergonomics, musculoskeletal disorders and computer work. *Occup Med (Lond)* 2005; 55:168-76.
182. Wahlstrom J, Hagberg M, Toomingas A, Wigaeus-Tornqvist E. Perceived muscular tension, job strain, physical exposure, and associations with neck pain among VDU users; a prospective cohort study. *Occup Environ Med* 2004; 61:954-5.
183. Waldenström M, Theorell T, Ahlberg G, Josephson M, Nise P, Waldenström K, Vingård E; MUSIC- study group. Assessment of psychological and social current working conditions in epidemiological studies: experiences from the MUSIC-Norrtälje study. *Scand J Public Health*. 2002;30:94-102.
184. Waldenstrom K, Lundberg I, Waldenstrom M, Harenstam A, MOA Research Group. Does psychological distress influence reporting of demands and control at work? *Occupational and Environment Medicine* 2003;60:887-91.
185. van den Heuvel SG, Boshuizen HC, Hildebrandt VH, Blatter BM, Ariëns GA, Bongers PM. Effect of sporting activity on absenteeism in a working population. *Br J Sports Med*. 2005 Mar;39:e15
186. van den Heuvel SG, Ijmker S, Blatter BM, de Korte EM. Neck/shoulder symptoms and hand/arm symptoms: results from the PROMO-study. *JOcup Rehabil*. 2007 Sep;17:370-82.
187. Vahtera J, Virtanen P, Kivimäki M, Pentti J. Workplace as an origin of health inequalities. *J Epidemiol Community Health*. 1999;53:399-407
188. Vermeulen M, Mustard C. Gender differences in job strain, social support at work, and psychological distress. *J Occup Health Psychol*. 2000 Oct;5:428-40.
189. Westerholm P. Challenges facing occupational health services in the 21st century. *Scand J Work Environ Health*. 1999 Dec;25:625-32

190. Westerlund H, Bergström A, Theorell T. Changes in anabolic and catabolic activity among women taking part in an alternative labour market programme. *Integr Physiol Behav Sci.* 2004 Jan-Mar;39:3-15.
191. WHO, The Ottawa Charter for Health promotion. 1986.
192. Victor L, Richeimer SM. Psychosocial therapies for neck pain. *Phys Med Rehabil Clin N Am* 2003;14:643-57.
193. Wiholm C. Advanced Knowledge work and Stress-related Symptoms. epidemiology and Clinical Intervention Studies. Thesis 2006. ISBN 91-554-6479-3
194. Wiholm C, Arnetz B. Stress management and musculoskeletal disorders in knowledge workers: The possible mediating effects of stress hormones. *Advances in Physiotherapy* 2007, (accepted).
195. Viljanen MA, Malmivaara. Effectiveness of dynamic training, relaxation training, or ordinary activity for chronic neck pain: randomised controlled trial. *BMJ Clinical Research* 2003; 329 (7413)
196. Vilnai-Yavetz I, Rafaeli A, Schneider Yaacov C. Instrumentality, Aesthetics, and Symbolism of Office Design. *Environment and Behaviour* 2005;37:533
197. Virtanen M, Kivimäki M, Elovainio M, Vahtera J, Ferrie JE. From insecure to secure employment: changes in work, health, health related behaviours, and sickness absence. *Occup Environ Med* 2003;60:948-53.
198. Virtanen P, Vahtera J, Kivimäki M, Pentti J, Ferrie J. Employment security and health. *J Epidemiol Community Health.* 2002;56:569-74.
199. von Thiele Schwarz U, Lindfors P, Lundberg U. Health-related effects of worksite interventions involving physical exercise and reduced workhours. *Scand J Work Environ Health.* 2008 Jun;34:179-88.
200. Woods V. Work-related musculoskeletal health and social support. *Occupational Medicine (London)* 2005;55:177-89.
201. Vogel J, Kindlund H, Diderichsen F. Arbetsförhållanden, ohälsa och sjukfrånvaro 1975-89 (In Swedish). Working conditions, health and sickness absenteeism 1975-89, Stockholm: Statistics Sweden (SCB), 1992. Report No 78.
202. Väänänen A, Kalimo R, Toppinen-Tanner S, Mutanen P, Peiró JM, Kivimäki M, Vahtera J. Role clarity, fairness, and organizational climate as predictors of sickness absence: a prospective study in the private sector. *Scand J Public Health* 2004;32:426-34.

STUDY I

submitted

STUDY II

[Related Articles, Links](#)

[Schell E, Theorell T, Hasson D, Arnetz B, Saraste H.](#)



Stress biomarkers' associations to pain in the neck, shoulder and back in healthy media workers: 12-month prospective follow-up.

Eur Spine J. 2008 Mar;17(3):393-405. Epub 2007 Dec 13.

PMID: 18075764 [PubMed - indexed for MEDLINE]

STUDY III

[Related Articles, Links](#)

[Schell E, Theorell T, Hasson D, Arnetz B, Saraste H.](#)



Impact of a web-based stress management and health promotion program on neck-shoulder-back pain in knowledge workers? 12 month prospective controlled follow-up.

J Occup Environ Med. 2008 Jun;50(6):667-76.

PMID: 18545094 [PubMed]

STUDY IV

Accepted