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# Postal Work – Work Organizational Changes as Tools to Improve Health

BY

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## **ABSTRACT**

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Postal work is performed in very different settings, and the works are e.g., drivers, letter carriers, postal sorters, and counter clerks. A finding that a small group of parcel sorters with a good psychosocial work situation had much lower health complaints than comparable workers with a worse psychosocial situation at work, indicated that it might be possible to improve mental and physical health among postal employees by improving work organization.

The theoretical framework for this thesis is the demands-control-support (DCS) model by Karasek, Theorell, and Johnson. Two cross-sectional studies were performed with questionnaires. In a study on 144 workers at a postal terminal associations were found between low support from superiors and high psychological work demands on one hand, and gastrointestinal complaints and sleep problems on the other. In another study on 655 postal workers in 6 different occupations high psychological work demands and low skill discretion were associated with low-back pain, and low social support at work with neck pain. In the study, the associations were different among men compared with women.

A follow-up study on the postal terminal (136 persons) was performed 8 and 12 months after an organizational change took place. The changes were aimed at improving the shift system, and the psychosocial work situation. Authority over decision and skill discretion increased, and sick leave decreased during the follow-up period. Changes in contact with superiors, team-mates, and skill discretion were associated with changes in gastrointestinal and sleep complaints. In another follow-up study, 82 individuals were studied before and 1 year after improvement of the psychosocial work environment. Musculoskeletal complaints were significantly reduced in the intervention group but not in the control group. Increased support from superiors was associated with fewer symptoms. Younger age and higher authority over decisions at baseline was associated with reduced symptoms at follow-up.

The main findings of this thesis are that there are significant associations between psychosocial work situation among postal workers psychosomatic and musculoskeletal symptoms, and that it is possible to reduce symptoms and sick leave, by changes of organization, and improvement of the psychosocial work situation.

*Key words:* Postal work, shift work, work organization, work stress, organizational change, gastrointestinal, sleep, musculoskeletal, psychosocial.

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Read not to contradict and confute,  
Nor to believe and take for granted

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But to weigh and consider

(Francis Bacon. Essays, Nr 50: On  
Studies. 1597)

## LIST OF PAPERS

The dissertation is based upon the following papers, which are referred to by their Roman numerals I-IV

- I. Wahlstedt K G I, Edling C. Psychosocial factors and psychosomatic complaints among postal workers. Eur J Publ Health 1994;4:60-64.
- II. Wahlstedt K G I, Edling C. Organizational changes at a postal sorting terminal – their effects upon work satisfaction, psychosomatic complaints and sick leave. Work & Stress 1997;11:279-91.
- III. Wahlstedt K G I, Björkstén M G, Edling C. Psychological factors at work and musculoskeletal symptoms among postal workers. Submitted.
- IV. Wahlstedt K G I, Nygård C-H, Kemmlert K, Torgén M, Björkstén M G. The effects of a change in work organization upon the work environment and musculoskeletal symptoms among letter carriers. Int J Occup Safety Ergon 2000;6:237-55

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## INTRODUCTION

Sweden Post is owned by the state and is one of the largest organizations in the country with 67.000 employees in 1988 (1). Since then there has been a substantial reduction of personnel and today about 42.000 are employed. Sweden Post has offices in all parts of Sweden. The employees traditionally have a high degree of loyalty and pride in their work and they feel that they are performing a very useful service for the society. The work is performed in very different settings, from large postal terminals to small post offices. The jobs are e.g., drivers, rural or town letter carriers, and counter-clerks. The work often starts very early in the mornings, in periods it is hectic and in some places, mostly in the postal terminals, the work is performed day and night all year round. The shift systems in the terminals were at least earlier often very complicated, (2) which implied the risk of obtaining psychosomatic disorders (2). Postal work is predominantly a very physical kind of work (1, 3, 4, 5, 6, 7, 8).

A reason for proposing organizational changes was a finding in our first study at a postal terminal (2). We found a small group of middle-aged men with a remarkably good health (as regarded gastrointestinal complaints, sleep difficulties, and feelings of well being) compared with the other male workers at the terminal. This group consisted of non-promoted parcel sorters who had chosen to remain in that position. In their work the knowledge of where to send parcels was very important, they could themselves decide how their work should be performed, and they could also work in their own pace and rotate among work tasks. Furthermore, they consisted a very coherent group with good relations and no formal leader. This indicated that it might be possible to improve mental and physical health among postal employees by improving work organization.

The literature concerning work organization, work stress, shift work, musculoskeletal as well as psychosomatic disorders is quite extensive. In the following is presented the most relevant literature for this thesis.

### **Work organization and work stress**

Before the industrial revolution in the 19<sup>th</sup> century production was mainly done as craftwork. Already Adam Smith (1776, 9) proposed specialization and division of

labour as a method to improve productivity and economy. Taylor (1911, 10) in his book “The principles of scientific management” stated that work tasks should be simplified as far as possible, unnecessary movements should be avoided, work pace increased, and social contacts between workers restricted. Engineers should supervise the work and production should be increasingly automatized. Taylor’s view had a tremendous impact and the old craftwork was substituted by working in assembly lines or similar. The Tayloristic model of work has remained the predominant in the Western World during the 20<sup>th</sup> century. There has been increasing criticism of the Tayloristic model, as the high demands and lack of control over work implicit of the model have been associated with several diseases (11).

*Demands-control-support model (DCS-model)*

In their book “Healthy Work”, Karasek and Theorell (11) concluded that the Tayloristic principles of scientific management are close to a work situation which leads to a high risk for psychological stress: “the job is low in task decision freedom, low in skill level, low in physical exertion, and the workers are socially isolated from workmates”. They considered that increasing the control opportunities at work should be the central strategy for changing the structure of an organization. In their model, based upon research in Sweden and USA (e.g., 12, 13, 14), psychological work demands (hectic, hard, and time pressured work, conflicting demands at work) interact with decision latitude (possibilities to learn new things, and to use skills at work, task variety, freedom to decide what and how work should be performed). Theoretically the negative impact of high psychological work demands can be avoided if the employee has high decision latitude, an active type of job. The combination of high psychological work demands and low decision latitude (high job strain) has been shown to be associated with the highest frequency of health problems (11, 12, 13, 14, 15, 16, 17). The direction of the organizational changes should be towards a low strain situation (low psychological work demands and high decision latitude) while the passive job situation (low psychological work demands and low decision latitude) can lead to demotivation and skill underutilization. Johnson (18) made the model three-dimensional adding social support (e.g., support from superiors and work mates) as the



third leg. The ideal psychosocial situation at work suggested by Karasek-Theorell-Johnson (reasonable psychological work demands, high decision latitude, and a high degree of social support at the workplace) is similar to the situation in the group of parcel sorters earlier described (2). Social support from co-workers and supervisors has also been regarded as important factors in working life by other authors (e.g., 19, 20, 21). House (1981, 19) suggested that social support can act as a main effect on work stress and health, and in addition as a buffer in three ways: by reducing the importance of experienced stress, by tranquilizing the neuroendocrine system making people less reactive to stress or by facilitating healthful behaviour. Cohen and Syme (20) concluded that there is scientific evidence that social support affects health both directly and through a buffering effect.

People differ in their reactions to stress. In a study on bus drivers under high levels of stress (22) it was shown that those who remained healthy had low levels of regressive coping behaviour, less constitutional vulnerability, more personality hardiness, and better social support at work (family social support did not influence health). A prospective study among air traffic controllers (23) showed during a 27 months follow-up period that overall morbidity was correlated with work stress, satisfaction with management, type A behaviour (driven, impatient, aggressive), and amicability (how popular the person was among his fellow workers).

Westlander (24) found very few documented organizational changes initiated by the workers themselves and also few organizational changes aimed at improving worker's health. She proposed a number of factors that could make organizational change a success both for mental health and for efficiency: the initiative should come from those directly involved and be forced through by them, support should be offered by specialists in personal development, room to work should be given by the management, it is important with a consciousness of the business-economical side of the matter, and familiarity with the organization in general, and with its structure. Karasek and Theorell (11), considering the negative health impacts of the predominating high stress work, contended that "changes in the workplaces are not only desirable but essential" and proposed a process which they called "work

reconstruction”, focusing on the psychosocial structure of work. This process consists of four stages:

1. *Engagement* phase, characterized by enthusiasm and energy. The energy is a necessary resource to overcome the obstacles of the redesign process. Information of job related problems is collected and a general theory is discussed (e.g., the DCS-model). Contact with all involved parties – union, supervisors, management, and safety committee is established, and a local theory is formulated based upon the issues defined by the members of the work situation itself.
2. *Search* phase, characterized by feedback both to the individual and the group. A forum for discussion is initiated. The employees find that the general model is not enough to provide the needed solutions. The group might feel that it is left without a structure, which might lead to anxiety and conflicts. In the discussions during the search phase, there is a realistic appraisal of the difficulties, but there may also be conflicts and disappointment.
3. *Change* phase, during which conflicts may arise because of change proposals from groups with conflicting interests. The staff and management should be informed that such conflicts might arise and that a relatively long phase of resolution could be necessary. It is important that the change process doesn't stop at this stage. In the discussions, the aims are to state practical redesign solutions and to formulate a new, revised, local theory.
4. *Diffusion* phase, which means monitoring of the results of the changes and communication of solutions to other groups. A successful change process also contributes to a new general theory.

Organizational changes are often stressful for the workers. Susan Jackson (25) showed that participation in decision-making reduced role strains (role conflicts and ambiguity), which are important precursors of both individual and organizational outcomes. Härenstam (26) found, in her work on prison personnel, large differences between objective and self-reported working conditions and concluded that the negative effects of the work environment could be diminished mainly by a supportive management style, a high consensus in work goals, and active work roles. In a study

on letter sorters (27), a higher degree of work satisfaction was found amongst manual sorters compared with code-sorters. The reasons for the difference were attributed to elements of discretion, autonomy, and social interactions in manual sorting, which were largely absent in code-sorting. Stress was closely related to work dissatisfaction in the code-sorting group but not in the manual sorting group. Stress was in manual groups and among supervisors expressed as fatigue, but in the code-sorting group stress took the form of anxiety.

That work environment influences the health of the workers has been recognized for a long time. Ramazzini, “the father of occupational medicine” was one of the first to make an attempt to a scientific approach to this problem (28). Another early pioneer was Jastrzębowski (29) who founded the concept of ergonomics (from Greek *ergon* = work and *nomos* = principle or law) as the science of work. He separated useful work from harmful work and stated that useful work was labour, entertainment, thinking, and dedication and that there were four major benefits from those kinds of work, namely property, ability, perfection, and felicity.

In the 20<sup>th</sup> century much scientific work have been performed to increase understanding of the nature of stress. Selye (30) defined stress as a non-specific reaction pattern (alarm, adaptation, exhaustion) to a wide range of stimuli, both physical and psychosocial. This view has later been challenged by research (31) demonstrating that “Living organisms are equipped with a number of different defence systems enabling them to deal with specific threats.” Kagan and Levi (32) proposed a conceptual model for psychosocially mediated disease. In their model, social structures (e.g., work sites) and processes (e.g., work events) lead to psychosocial stimuli which combined with the psychobiological programme lead to mechanisms (e.g., stress) and eventually disease and lack of well being. This process is modified by interacting variables (e.g., social support and coping behaviour) and by feedback mechanisms.

Many authors have studied the role of catecholamines (e.g., Frankenhauser, 33). She found that epinephrine/norepinephrine was correlated with mental activity, regardless whether the affect is positive or negative, while cortisol was correlated with negative affect and passivity (lack of control).

Seligman (34) demonstrated that a feeling of helplessness was associated with disease. He stated that if a person feels that he/she cannot exert control contrary to significant others in the same situation, learned helplessness could be the result. If this state is stable (in time) and global (as opposed to specific) a chronic helplessness and subsequently a state of low mood and depression will be the result.

## **Shift work**

### *Circadian rhythm*

Diurnal patterns are found among all living organisms (35). Among humans the body temperature is highest when we are awake and alert (35, 36) and different hormones (e.g., cortisol, adrenaline) have typical circadian rhythms (35, 36, 37). The biologic clock was found in studies on persons isolated from the outer world to be set at approximately 25 hours (35, 36, 37). Our adaptation to the 24-hour's day is possible through external influences ("zeitgebers") as light/darkness, habits, social patterns, watches (35, 36). The highest sleepiness occurs in the morning (05.00 h), and around 15.00 (38), and the lowest sleepiness is in the evening (19.00 – 23.00 h) (38). In transmeridian flights, it is easier to recover after a westbound flight than after an eastbound one, because by flying westbound the day is prolonged which is easier to cope with, considering man's spontaneous day of 25 hours (35).

### *Shift work and health*

Shift workers have a poorer quality of sleep and greater variability in the length of sleep after night (2, 36, 37, 39, 40, 41, 42, 43, 44), and before early morning shifts (2, 40, 43, 44) compared with day workers. This has been attributed the violation of the circadian rhythm. Sleep difficulties after night-shifts increase with age (2, 36, 37, 41, 42, 43), a decreased circadian flexibility could be involved or more time needed for recuperation with increasing age could cause accumulation of negative effects (43). It seems to be impossible to improve one's ability to completely adjust over time, even with permanent night work (42, 43, 44). In one study, the deterioration of health was significant after about 12 years of shift work which was ascribed to a high rate of sleep

disturbances and a pronounced reduction of well being, and increases in gastrointestinal and cardiovascular ailments (45). The sleep is longer – compensatory – after day shifts and the workers often compensate for short sleep after night shifts with napping (40, 44, 46). Sleepiness at work, especially during night shifts is common and can be hazardous in some occupations (36, 37, 42, 44, 47). To minimize the negative impact of the disturbed circadian rhythm a clockwise distribution of the shifts has been suggested (37, 42, 44). This has been tested among policemen in Sweden (48, 49). The clock-wise shift rotation beginning with morning shift, followed by afternoon shift, night shift, and day off duty, was associated with less feelings of being stressed, lesser extent of tiredness, reduced gastrointestinal problems, and improved sleep. However, with a clockwise rotation, the free of work periods become shorter than with a counter-clockwise rotation. For that reason one group (49) returned to the counter-clockwise rotation schedule.

In addition to sleep problems, shift work has been associated with a higher frequency of other health problems: e.g., unspecific gastrointestinal complaints (2, 36, 37, 45, 48, 49, 50, 51, 52), peptic ulcers (52), and cardiovascular diseases (37, 45, 50, 53, 54). An experimental study showed that blood pressure and serum triglycerides were reduced if counter-clockwise shifts were changed to clockwise – on the same time sleep length and quality of sleep was improved (55). Psychic disturbances (irritation/strain) have been reported among shift workers (51), and those symptoms and psychosomatic disturbances remained (51) or were even more pronounced among those who had left shift work for health reasons (56).

## **Work related sleep and gastrointestinal disturbances**

### *Sleep difficulties*

There is plenty of scientific evidence that shift work is associated with sleep difficulties (see above). Sleep is a necessary period of recovery (57). It is divided in 5 stages – REM and four non-REM stages. REM sleep is of importance for cognitive function and non-REM sleep (especially SWS – ‘slow wave sleep’, stages 3-4) for recovery of physical energy (anabolism) (58). In humans, normal sleep is between 6

and 9 hours a day (59). Impaired sleep has well-known, profound effects on well being, performance, social life, and can lead to accidents (35, 47, 57). A pattern of bad sleep has also been associated with e.g., myocardial infarction (60). Worrying, stress at work, personal losses and other forms of psychic load are strongly correlated with insomnia and disturbed sleep (57). It has been shown that sleep disturbance increased with increasing job strain (15). In depression there is a reduction of SWS, which leads to a shallow sleep with early awakenings in combination with anxiety (61), which results in the feeling of not being rested. In contrast with the situation for a depressed patient, in the shorter sleep after a night shift almost all reduction is due to reduced stage 2 and REM sleep, while the SWS is adequate in spite of the shortened sleep (62). Sleep difficulties are very common in the community, the prevalence increases with age, and the prevalence is higher among women (58, 63). There has also been shown a great variability between workers of different occupations (64), but Cherry (65), in a community based cohort study, found that sleep problems were related to prior susceptibility to anxiety rather than to stressful factors at work.

### *Gastrointestinal complaints*

Some gastrointestinal disorders have for a long time been considered as psychosomatic: e.g., peptic ulcer, non-ulcer dyspepsia (NUD), irritable bowel syndrome (IBS), and ulcerative colitis. Alexithymia, i.e., the inability of a person to interpret his/hers feelings and to express them has been associated with psychosomatic disturbances (66, 67, 68). In the following, only the functional complaints (IBS and NUD) are discussed. The symptoms of NUD are similar to those of peptic ulcer: e.g., epigastralgia, belching, heartburn, and nausea (69). Nyrén (70) concluded that psychological factors are crucial in the aetiology of NUD. Psychiatric morbidity, low job satisfaction, feeling of low autonomy, economic and other personal worries were found to be the most important determinants for NUD (70). NUD and IBS are difficult to separate (69). The symptoms of IBS are abdominal pain, flatulence, and oppression, which may or may not be combined with obstipation and diarrhoea (71). The genesis of IBS is multifactorial with a genetic component. Dietary factors, emotional stress, and psychological disturbances can induce the symptoms that tend to be chronic with

worse and better periods that are influenced by the psychological state (71). An increase in hospitalizations for gastrointestinal illness has been found for persons in jobs that were hectic, monotonous, and with few opportunities to learn new things (72).

Levi (1987, 73) made a psychosocial approach to dyspepsia. He pointed at emotional reactions (anxiety, depression, hypochondria), behavioural reactions (self-destructive behaviour, abuse of alcohol, drugs and tobacco, and resistance to prevention, therapy, and rehabilitation), and physiological reactions. Through these mechanisms, psychosocial stressors can precipitate ill health and one of the targets of such influences is the gastrointestinal tract. This negative impact can be buffered by coping and social support. Other authors have found similar associations (74) and there has been reported successful treatment of functional gastrointestinal disturbances with group behavioural medicine intervention (75).

### **Work related neck-shoulder and low-back symptoms**

An association between workload and musculoskeletal symptoms has been recognized for a long time. Ramazzini (28) observed that prolonged sitting, uncomfortable work postures, and repetitive works were all related to musculoskeletal disorders. Heavy lifting (6, 76, 77), exposures for whole body vibrations (WBV) (78, 79), and working in a twisted or bent posture (79, 80, 81), have been associated with low-back ailments. Ergonomic risk factors associated with neck problems are e.g., repetitive work (82), static work (82, 83, 84), and working in a twisted or bent posture (84). Nygård (85), found that work intensity didn't have any training effect on muscular strength, on the contrary, heavy physical workload seemed to be a factor that deteriorated strength, and muscular strength was reduced after 40 years of age, which could contribute to musculoskeletal trouble. Injuries are sometimes caused by light repetitive work and an explanation to that could be the "Cinderella theory" by Hägg (86). This theory states that the same muscle fibres are activated first and continue to work longest during the contraction, i.e., some muscle fibres are working all the time even when work load is low. It has also been shown (87) that static work in arm and hand could lead to impaired blood circulation in the muscles and that only a fraction of the maximum

voluntary capacity (MVC) can be utilized for more than short time periods without risks. Also psychosocial factors at work have been associated with musculoskeletal symptoms (e.g., 17). High job demands have been associated with low-back pain (88, 89), and neck problems (89). Job dissatisfaction has been associated with symptoms from the neck (83, 84, 90), and low back (88, 89, 90, 91). Low social support from superiors and team-mates has been associated with neck (83, 89), and low-back pain (88, 89, 91). Also low decision latitude has been associated with musculoskeletal problems (89, 90). Personality traits as poor sense of coherence have been associated with pain in neck and shoulders (92), and feelings of stress, psychological and emotional problems with low-back pain (89). High perceived psychological demands have been found to be associated with a higher pain threshold in the neck and shoulder region when persons were not under high psychological stress but during stress, those who reported low decision latitude were more sensitive to pain than others, which was aggravated in individuals also reporting sleep difficulties (93).

Letter carriers have a physically demanding work in which the physical workload from time to time exceeds current recommendations (1, 7, 8). Oja et al. (7), found that the demands were higher among women than among men and higher in mail delivery in the suburbs than in downtown areas. They also found that the relative aerobic strain increased with increasing age, especially after the age of 50 years. On the contrary, the physiological responses in parcel sorting have been shown, in a study of healthy men, to be on an acceptable level (3). In an earlier study on postal sorters (both letter- and parcel sorters) we found (4), that most sorters were exposed to heavy lifting, repetitive work, and working in a bent and twisted posture. However, those exposures did not exceed current recommendations. It has been shown (94), that performance time in mail sorting is determined primarily by cognitive, not physical, task components.

High prevalence of symptoms from the upper extremities and the knees among postal workers has been shown (4, 95), and musculoskeletal disorders have increased. In Britain (96), there was an increase in sick leave for musculoskeletal disorders among postal workers between 1960 and 1980 by 88% for men and 93% for women. In Sweden Post, there was a sharp increase in the incidence of reported chronic work related musculoskeletal injuries between 1986 and 1990 (1). An unacceptable static



work load on the shoulder and neck muscles have been demonstrated during letter sorting in an experimental study (5). In a cohort study among letter carriers (6), weight carrying was related to problems of the shoulders and neck, when controlled for age, distance of walking, and years at work, latest work, and body size.

The prognosis for patients with severe neck and low-back ailments have been shown to be poor (97, 98, 99, 100), especially for persons over 35 years of age (99). The prevalence increased with age among manual workers but not among office workers (97), and the musculoskeletal symptoms were unchanged (97) or increased (100) after retirement. Prophylactic measures have mostly been disappointing. Some authors have reported positive results of physical training (e.g., 101), while others didn't find such an association (e.g., 102). Evidence for the effects of back and neck schools are lacking (101, 103, 104). Westgaard and Winkel (105) found no effects of interventions on mechanical exposure alone. They and other authors propose organizational culture interventions (11, 82, 105, 106), and to focus on workers at higher risk of getting musculoskeletal problems (105). Successful reallocation of workers with neck problems before they have become chronic have been reported (82).

## **AIMS OF THE THESIS**

This thesis has as its main objective to study the possible associations between work organization, psychosocial factors and health. The outcome measures are musculoskeletal problems and psychosomatic complaints, such as sleep difficulties and gastrointestinal symptoms. Furthermore, the question if improvements of work organization, including improvements of shift work, might influence such symptoms in a positive way was addressed.

The literature concerning interventions in work organization aimed at reducing symptoms is relatively sparse. The reason for that is the obvious problem of studying changes in large groups of workers since there are so many factors that can influence the change process, which thereby becomes difficult to control in a scientific manner. However, many authors have proposed organizational changes to improve the health of the workers, and to gather more scientific evidence for such interventions emphasis

on changes in dynamic, organizationally less stable work places has been suggested by Silverstein (107) in studying the effects of work organization on musculoskeletal symptoms.

When discussing problems with postal work and the need for interventions at the start of this work, we found that there was a lack of studies on postal workers, especially with respect to the psychosocial factors at the workplace and that follow-up studies concerning organizational changes aimed at reducing the rate of psychosomatic and musculoskeletal disorders in the working staff were lacking.

Below are the main objectives for each study of the thesis:

1. To investigate the possible associations between psychosocial factors at work with gastrointestinal complaints and sleep difficulties (study I)
2. To study an organizational change at a workplace with regards to changes in psychosocial factors at work and possible associations between these and changes in gastrointestinal complaints, and sleep difficulties, and sick leave (study II)
3. To investigate the possible associations between psychosocial factors at work and musculoskeletal symptoms (study III)
4. To study an organizational change at a workplace focusing on changes in psychosocial factors at work and possible associations between these and changes in musculoskeletal symptoms (study IV)

## **ETHICAL CONSIDERATIONS**

All studies were performed in cooperation with The Swedish Foundation for Occupational Health and Safety for State Employees. They were part of the ordinary occupational work performed for the Sweden Post. The data was treated confidentially and results were presented in such a way that no individuals could be traced.

Studies I-II were performed in cooperation with Uppsala Post Region and were approved by the employer and the union, and a steering group consisting of representatives from both employer and union was consulted. All postal workers volunteered to participate in the study.

Study III was performed in cooperation with Sweden Post and the Postal Regions of Sollentuna, Hässleholm, Skövde, and Uppsala. The employer and the union approved it, and a central reference group consisting of representatives from both employer and union in Sweden Post was consulted. All participants volunteered to participate in the study. The Swedish Council for Work Life Research supported the study.

Study IV was performed in cooperation with the Postal Region of Sollentuna. The employer and the union approved it, and a reference group consisting of representatives from both employer and union was consulted. All participants volunteered to participate in the study. The Swedish Council for Work Life Research supported the study.

## SUMMARY OF PAPERS

### **Study I: Psychosocial factors and psychosomatic complaints among postal workers.**

The aim of this study was to evaluate the hypothesis that a less satisfactory psychosocial situation at work is associated with increased psychosomatic disturbances (sleep difficulties, gastrointestinal complaints). The study was also intended to be used as a baseline study for a prospective study (study II). The Postal Terminal of Uppsala had a few years before the study been relocated (108) which most of the workers were against. Staff dissatisfaction forced the management to make a review of the situation at the workplace. It was found that the work was monotonous and little stimulating, the information system was unsatisfactory, and the role of the management was unclear, workload had increased, and productivity had decreased. Staff turnover was high, and so was the frequency of sick leave.

#### *Participants*

After exclusion of 59 persons who were on sick leave, other absences or who planned to leave work in the near future, 191 persons, (144 men and 47 women), working at the postal terminal were invited to participate in the study. 143 persons, 105 men and 38 women, completed the questionnaires (75.4%). Mean age was for the men 34 years and for the women 32 years. The majority of respondents were letter sorters (61 persons) and the most common schedule included night shifts (61 persons). The other work-groups were 6 supervisors, 4 persons handling insured mail, 15 first postmen, 14 parcel sorters, 38 drivers, and 5 others.

#### *Questionnaires*

Five self-administered questionnaires were used, concerning gastrointestinal complaints, 5 items, sleep quality, 10 items, psychological work demands and decision latitude, 11 items, psychosocial factors, 16 items, and questions about the present work situation, 3 items. The psychological work demands and decision latitude questionnaire (12, 15) was factor analysed together with the questionnaire on psychosocial factors resulting in four indices used in the subsequent analyses:

psychological work demands, decision latitude, contact with superiors, and contact with team-mates. These indices were reliability tested by Cronbach's alpha (109). In addition an index on overall social support was made which included the indices contact with superiors and team-mates and some additional variables. A three dimensional model (18) was also used. The dimensions were social support, psychological work demands, and decision latitude. Each dimension was dichotomised as high and low. Indices were also made for sleep quality and gastrointestinal complaints. The questionnaires were distributed to each eligible person by their supervisor and returned by the persons by mail to the investigators. 1-2 reminders were sent to persons who did not answer.

### *Statistical methods*

The data were analysed by variance analysis (Anova),  $\chi^2$ -test and stepwise multiple regression. The SPSS-PC+ programme was used in the calculations and the significance level set to 5%.

### *Results*

Contact with superiors differed very little between the occupational groups. Satisfaction with contacts with team-mates was highest among drivers while letter sorters were the least satisfied. Letter sorters had the highest scores on psychological work demands index and scored lowest on decision latitude index. Supervisors scored highest on decision latitude index and drivers scored lowest on psychological work demands index. The respondents reported few gastrointestinal symptoms but a substantial amount of sleep difficulties.

Low social support, unsatisfactory contact with superiors, and high work demands were significantly correlated with higher reports of gastrointestinal complaints whereas low decision latitude was not (table 1). Low social support, unsatisfactory contact with superiors and team-mates and high work demands were significantly correlated with higher ratings on the sleep quality index while low decision latitude was not (table 1).

**Table 1.** (Table 4 in article).  $\chi^2$ - calculations of 2\*2 tables between scores on exposure indices and symptoms' indices (n = 143)

Exposure	$\chi^2$	Significance	Minimum expected frequency
A. Gastrointestinal complaints index			
Low social support	14.10	$p<0.001$	7.5
Unsatisfactory contact with superiors	12.18	$p<0.003$	7.7
Unsatisfactory contact with team-mates	5.79	ns	5.4
High work demands	9.32	$p<0.01$	6.2
Low decision latitude	0.45	ns	7.6
B. Sleep quality index			
Low social support	26.28	$p<0.0001$	8.0
Unsatisfactory contact with superiors	23.23	$p<0.001$	8.7
Unsatisfactory contact with team-mates	11.90	$p<0.003$	5.0
High work demands	22.59	$p<0.0001$	9.4
Low decision latitude	0.94	ns	7.6

In ANOVA analyses significant correlations were found between the gastrointestinal complaints index and unsatisfactory contacts with superiors ( $p<0.01$ ) and between sleep quality index and high psychological work demands ( $p<0.01$ ), unsatisfactory contact with superiors ( $p<0.01$ ) and team-mates ( $p<0.05$ ).

In the three dimensional model, no significance testing was performed due to the small numbers in some subgroups. There were no gastrointestinal complaints among workers with a high social support in a low-strain work situation (low psychological work demands; high decision latitude). For gastrointestinal symptoms as well as for sleep difficulties, the highest frequencies of symptoms were found among those with

low social support and an active work situation (high psychosocial work demands and high decision latitude). For gastrointestinal complaints as well as for sleep difficulties, workers with low social support always had a higher frequency of symptoms than workers with high social support regardless of the type of psychosocial work experience.

## **Study II. Organizational changes at a postal sorting terminal**

A follow-up study of the cross-sectional study (study I) was performed in order to investigate organizational changes aimed at improving psychosocial work climate, reducing workload, sick leave, and staff turnover. Another aim was to study the health effects of the changes on reporting sleep difficulties and gastrointestinal symptoms. In the terminal the work tasks were manual sorting of letters and parcels by postal codes, and distribution of parcels and sacks of sorted letters to post offices and companies. The problems before the organizational changes were performed were that the work was monotonous and not very stimulating, the information system was unsatisfactory and the role of the management was unclear, the workload had increased and the productivity decreased, and staff turnover and sick leave were high. Furthermore, the shift system was very complicated for most full-time workers.

### *Participants*

144 persons that answered the cross-sectional study were invited to participate. 8 persons had answered the first study anonymously, 12 persons left work during the follow-up period and 24 didn't answer one or both of the follow-ups. The analyses were made in the group of 100 persons who responded on all three occasions.

### *Changes in the working conditions*

The staff was invited to co-operate in the planning of the organizational changes.

1. Two separate production areas were formed, each with its own management and budget. In one of these, the tasks were sorting of letters, insured mail, and parcels. In the other, the tasks were handling of company parcels, and transport to post offices and companies. The role of the management was clarified and

production goals were stated more precisely. The total number of supervisors was reduced from eight to five and those who remained were carefully selected, which increased the ability of the staff to influence the work situation.

2. The number of senior postmen was reduced from twelve to seven, and their authority was increased.
3. To handle periods of excessive workload five letter sorters were employed (+2.5%).
4. Work groups of 4-5 individuals were created but the tasks were not changed.
5. The information system was improved and an automatic food vending machine and microwave ovens were introduced.
6. The shift system was profoundly changed, the early morning shifts, starting before 06.00 h were abandoned and the types of shifts were greatly reduced. The aim of introducing a clockwise rotation could only be partly carried out due to opposition among the younger workers who preferred the longer periods of leaves in a counter-clockwise system.

### *Questionnaires*

The same questionnaires were used as in study I. They were distributed three times, immediately before the changes were performed and 8 and 12 months later. In the analyses the index decision latitude was divided into two indices in analogy with its constructors (16): skill discretion and authority over decisions.

### *Statistical methods*

Paired *t*-tests were used in the analyses of changes of the psychosocial and symptom indices during the three surveys. Stepwise multiple regression analyses with the psychosocial indices, gender, age, daily working time, attitude to the changes, a direct question on satisfaction with superiors as independent variables, and symptom indices as dependent variables were performed to analyse associations at each follow-up. Changes in independent variables were analysed against changes in dependent variables with one-way analysis of variance and multiple range test using the LSD-procedure. The level of significance was set at 5% in all statistical analyses.



**Table 2.** (Table 3 in article). Changes in independent variables between the initial investigations and follow-ups at 8 months and 1-year (n = 100)†

Index	Difference between start and first follow-up			Difference between first and second follow-up			Difference between start and second follow-up		
	<i>t</i>	mean	<i>p</i>	<i>t</i>	mean	<i>p</i>	<i>t</i>	mean	<i>p</i>
Psychological work demands	-.1	-.02	.92	2.4	.5	.02	1.5	.4	.13
						neg			
Skill discretion	1.6	.4	.11	1.8	.5	.08	3.1	.8	.01
						pos			pos
Authority over decisions	1.7	.2	.10	.8	.1	.44	2.1	.3	.04
									pos
Contact with superiors	-2.2	-.4	.03	2.5	.5	.02	.1	.01	.96
			pos			neg			
Contact with team-mates	-.1	-.02	.91	.6	.1	.59	.0	.0	1.00
Easiness/uneasiness	-2.7	-.3	0.01	3.8	.5	.000	.8	.1	.44
			pos			neg			

† Paired *t*-tests. *T*-values, means for changes in independent variables and *p*-values for the changes. For significant changes, the direction of the change, positive or negative, is shown.

### Results

There were no differences in gender between the responding and non-responding groups but the latter were considerably younger than the responders. Those who did not respond on any of the follow-up occasions were at the start of the project significantly more dissatisfied with the contact with superiors ( $p < .01$ ), contact with team-mates ( $p < .001$ ), social support ( $p < .01$ ) and skill discretion ( $p < .05$ ) compared with the responders (who responded to both follow-up occasions).

At first follow-up contact with superiors had changed in a positive direction ( $p=.03$ ) but it returned to the level it was at baseline to the second follow-up. On the second follow-up both skill discretion ( $p=.01$ ) and authority over decision ( $p=.04$ ) had increased. Psychological work demands and contact with team-mates didn't change at all. Difficulties with sleep increased to the first follow-up ( $p<.05$ ) but decreased to the second follow-up (ns). Gastrointestinal complaints did not differ significantly over the study period.

Total sick leave was significantly reduced for full-time employees from 9.3% to 8% ( $p<.05$ ) during the follow-up year and for part-time employees from 8.5% to 6.1% ( $p<.05$ ). The reduction was most evident during the first follow-up period of 8 months.

An unsatisfactory contact with superiors was significantly correlated with higher ratings in the gastrointestinal complaints index on both follow-up occasions and with higher ratings in the sleep quality index at the second follow-up. High psychological work demands were significantly correlated with higher (worse) ratings in the sleep quality index on both follow-up occasion and with higher ratings in the gastrointestinal complaints index at *follow-up two*<sup>1</sup> (Table 3). On the second follow-up, a low rating of authority over decision was associated with higher ratings in the gastrointestinal complaints index and female gender with higher ratings in the sleep quality index.

Individuals who had a worse contact with superiors at follow-up two rated significantly higher on both gastrointestinal complaints index and sleep quality index compared with those who had an unchanged or improved contact with superiors. Individuals who had an improved contact with team-mates at follow-up two rated significantly lower on gastrointestinal complaints index than those who had an unchanged or worsened contact with team-mates. Individuals who had a worse contact with team-mates at follow-up two rated significantly higher (worse) on sleep quality index than those who had an unchanged or improved contact with team-mates. Individuals who had lowered (worse) scores for skill discretion at follow-up two rated

<sup>1</sup>In the text of the article, this was erroneously written: "first follow-up".

significantly higher on gastrointestinal complaints index and sleep quality index than those who had an unchanged or better skill discretion.

**Table 3.** (Table 4 in article). Significant correlations between independent and dependent variables on each follow-up occasion (n = 100).<sup>†</sup>

Dependent variable	Independent variable	$\beta$	$R^2$	$p$
<i>A. First follow-up occasion (8 months)</i>				
Gastrointestinal complaints index	Contact with superiors	.35	.13	<.001
	Attitude to the performed changes	.32		<.001
Sleep quality index	Psychological work demands	.28	.21	<.01
<i>B. Second follow-up occasion (1 year)</i>				
Gastrointestinal complaints index	Contact with superiors	.21		<.05
	Psychological work demands	.25		<.01
	Authority over decisions	.21	.18	<.05
Sleep quality index	Contact with superiors	.32		<.001
	Contact with team-mates	.27		<.01
	Psychological work demands	.28		<.01
	Gender (female)	.24	.35	<.01

<sup>†</sup> Multiple regression, stepwise method. Independent variables: Gender, age, daily working time, attitude to the performed changes, a direct question on satisfaction with superiors and the indices: contact with superiors and team-mates, work demands, skill discretion, and authority over decisions. Dependent variables: gastrointestinal complaints index, sleep quality index.

### **Study III: Psychosocial Factors at Work are related to Musculoskeletal Symptoms among Postal Workers**

The aim with the study was to analyse the possible association between psychosocial factors at work and musculoskeletal complaints among postal workers.

#### *Participants*

655 postal workers in six occupations, post masters/letter carrier superiors, rural letter carriers, town letter carriers, letter sorters, counter clerks, and company mail handlers were included in the study. They worked in four different postal regions of which two were in rural and two in city areas.

#### *Questionnaire*

A questionnaire was distributed to the participants. The background and psychosocial questions were also used in study I and II. In addition questions about physical load and musculoskeletal complaints were added (110). The physical load questions were factor analysed. The factors were reliability tested with Cronbach's alpha (109) resulting in the indices: duration of exposure for repetitive work, duration of uncomfortable work postures in sitting, duration of uncomfortable work postures in standing, and duration of working in a twisted or bent posture. The standardised Nordic questionnaire for the analysis of musculoskeletal symptoms (111) was used to assess the 12-month's prevalence.

#### *Statistical methods*

Forward stepwise multiple logistic regression analysis was used to assess the associations between psychosocial factors at work controlling and not controlling for physical load (112). Gender, age and years in current job were included in the analyses. The independent variables (except gender, age, and years in current work) were treated as so called dummy variables. In addition, a forward stepwise logistic analysis was used to test the association between three dimensions of psychosocial work situation (18) and 12 month's prevalence for symptoms from neck/shoulders/thoracic region. Each of the dimensions of the psychosocial variable

(psychological work demands, decision latitude, and social support indices) was dichotomised as high or low. Odds ratios and 95% confidence intervals were calculated in all analyses except in analyses where men and women were investigated separately where *p*-values were used with a significance level of 5%.

**Table 4.** (Table 5 in article). Psychosocial/organizational factors. Logistic regression. Stepwise forward analysis (WALD)

Region	Exposure/ independent variable	Not controlling for physical load		Controlling for physical load	
		Odds /ratio	95% confid. interval	Odds /ratio	95% confid. interval
Neck	Gender (female)	1.7	1.1-2.4	2.1	1.4-3.1
	Unsatisfactory contact with team-mates	ns	-	2.2	1.3-3.8
	High psychological work demands	1.9	1.2-3.0	ns	-
	Working in a twisted or bent posture	-		1.9	1.1-3.3
	Uncomfortable sitting postures	-		2.0	1.2-3.3
Low back	High psychological work demands	2.0	1.2-3.1	1.8	1.1-2.9
	Low skill discretion	2.1	1.3-3.4	2.1	1.3-3.6
	Duration (years) of present work	1.02	1.0-1.04	ns	-
	Working in a twisted or bent posture	-		2.2	1.4-3.7

### *Results*

In the analyses not controlling for physical workload, workers with high psychological work demands had more complaints from the neck and low back. The women had more complaints from the neck than the men. Those with low skill discretion had more complaints from the low back. A longer duration (years) of present work was also associated with more complaints from the low back.

When controlling for physical load, workers with high psychological work demands reported more complaints from the low back but not from the neck. The women had more complaints from the neck than the men. Persons with unsatisfactory contact with team-mates had more complaints from the neck and persons with low skill discretion more symptoms from the low back.

There were some significant differences between the two genders when data for men and women were analysed separately. Among men, a longer duration of working in a twisted or bent posture was associated with symptoms from the neck. Among women, there were associations between -- unsatisfactory contact with team-mates and uncomfortable sitting postures -- and symptoms from the neck. Among men, duration (years) of present work was associated with symptoms from the low back. Among women, there were associations between -- high psychological work demands, low skill discretion and working in a twisted or bent posture -- and symptoms from the low back.

In the three dimensional model, when social support was reported to be high, there was a trend to report more complaints from the neck/shoulder/thoracic region among those with high psychological work demands, especially if it was combined with low decision latitude. If social support was reported to be low there were significantly higher ratings for complaints from the neck/shoulder/ lumbar regions except for those who reported the combination of low psychological work demands and high decision latitude. In the group reporting high psychological work demands and low decision latitude there were considerable gender differences. In the group with high social support the OR for reporting symptoms was 3.7 (ns) for the men and 1.3 (ns) for the women. When social support was low the OR for reporting symptoms was 1.0 for the men and 4.8 ( $p=.01$ ) for the women.

#### **Study IV. The effects of a change in work organization upon the work environment and musculoskeletal symptoms among letter carriers.**

The object of this study was to follow and evaluate a change of work organization in a postal district with respect to its effects on work environment and musculoskeletal symptoms among mail handling staff working with letter sorting and delivery of mail (see also 95). The reason for the organizational change was desires from the management, in cooperation with the union, to achieve a better work environment, improve staff well being, reduce sick leave and staff turnover. The workers could choose to be transferred to new premises where a new modern organization was introduced or remain in the old postal terminal where only minor changes were planned.

In the study the effects among older persons were of special interest.

##### *Participants*

82 persons participated in the questionnaire study in both baseline and follow-up inquiry one year after the changes were performed (83% of the target group). The group was in the analyses divided in “younger” (<35 years) and “older” ( $\geq 35$  years). Two third stayed in the old postal terminal and one third moved to the new terminal. Those who stayed were older (mean age 32 years compared with 28 years) and had worked longer in their occupation (mean 4 years compared with 2 years) than those who moved. 6 persons in the “older” group were elected by the management to participate in the observation studies and they volunteered to do so.

##### *Performed organizational changes*

The aim of the changes was to create a new and modern organization at the new terminal B and no changes were planned at the old terminal A. However, some of the changes performed in B were also introduced in A. The most important differences were that the superiors of terminal B got a greater responsibility than those at terminal A, the teams in terminal B had joint responsibility for the mail sorting districts of the team while in terminal A each letter carrier had responsibility for his/her own district only. Some new tasks were introduced in terminal B and 2 persons were included in

every team to cover up for shorter periods of staff reduction, the teams had also time for planning their work and were stimulated by the introduction of a bonus system. At terminal B the premises were rebuilt and each team had their own room, in terminal A only minor changes were done.

### *Questionnaire*

The same questionnaire as in study III was distributed immediately before and one year after the performed changes.

### *Observation methods*

To study the demands of the work the AET method (113) was used. It consists of 216 items concerning work content, work equipment, work organization, remuneration, and physical and psychosocial demands on the individual.

To study the individual's work hazards PLIBEL (114) was used. The analysis is dichotomous (no risk, risk) and modifying factors, e.g., influence on work tasks, urgency, and presence of certain physical factors is considered.

Both these methods were performed before and one year after the changes. Trained analysts performed the analyses.

### *Statistical methods*

Wilcoxon's matched-pairs signed-ranks test (115) was used to compare physical exposure, musculoskeletal complaints, and psychosocial and organizational changes before and after the change of organization. Stepwise discriminant analysis (116) was performed to assess prognostic factors for improvement of symptoms among those who had symptoms from neck, shoulders, and thoracic region at baseline. Stepwise forward logistic regression analysis (112) was used to analyze associations between changes in exposure and changes of symptoms. A significance level of  $p < .05$  was accepted. AET analyses resulted in ordinal scale data (according to Landau 1989, 117) from which work profiles were constructed. PLIBEL was analyzed qualitatively.



**Table 5.** (Table 3 in article). Reported psychosocial factors at the old (A) and the new (B) terminals at baseline and at the follow-up (n = 82). Possible values for each index are indicated in parentheses

Index (Possible values)	Stayed in A n = 55		Moved to B n = 27		Study group n = 82	
	Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Social support <sup>a</sup> (16-64)	29.1	27.3	28.2	25.8 <sup>1</sup>	28.8	26.8 <sup>2</sup>
Contact with superiors <sup>a</sup> (5-20)	7.7	7.7	6.8	7.4	7.4	7.6
Contact with team-mates <sup>a</sup> (4-16)	6.2	6.5	6.2	5.7	6.2	6.2
Psychological work demands <sup>b</sup> (5-20)	12.9	11.6 <sup>3</sup>	13.2	11.6 <sup>4</sup>	13.0	11.6 <sup>5</sup>
Skill discretion <sup>b</sup> (4-16)	10.0	9.8	9.2	9.9	9.8	9.9
Authority over decisions <sup>b</sup> (2-8)	5.3	5.8 <sup>6</sup>	5.8	5.7	5.5	5.8

Notes. 1— $p = .04$ , 2— $p = .02$ , 3— $p = .001$ , 4— $p = .006$ , 5— $p = .000$ , 6— $p = .03$ ;  
a---higher values indicate lower social support; b---higher values indicate more demands, skill discretion, and authority over decisions

### Results

Physical load didn't change significantly. Psychological work demands were significantly reduced in both terminals. Those who moved to terminal B reported significantly improved social support and those staying at A significantly improved authority over decisions. The "older" workers reported significantly improved social support and authority over decisions compared with the "younger" workers at follow-up.

The group that moved to terminal B reported a significant reduction of symptoms from shoulders and thoracic regions (table 6). The “younger” but not the “older” workers had significantly reduced symptoms from shoulder, thoracic, and lumbar regions (Table 7).

**Table 6.** (Table 4 in article). Twelve-month prevalence of musculoskeletal symptoms at the old (A) and the new (B) terminals at the baseline and at the follow-up.

Prevalence was calculated in percentage of delivered answers excluding dropouts.

Region	Stayed in A n = 55		Moved to B n = 27		Study group n = 82	
	Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Neck	40	26	46	44	42	32
Shoulders	51	37	52	28 <sup>1</sup>	51	34 <sup>2</sup>
Thoracic	29	21	33	8 <sup>3</sup>	30	17 <sup>4</sup>
Low-back	43	30	42	36	43	32

Notes. 1— $p = .02$ , 2— $p = .009$ , 3— $p = .02$ , 4— $p = .02$

Those who had musculoskeletal symptoms from the upper part of the body and were symptomless at follow-up were significantly younger (mean age 27.6 years) and reported a significantly higher authority over decisions, 5.8, at the baseline compared with those who did not improve (mean age 32.8 years, authority over decisions 4.6).

A disappearance of symptoms from the shoulders from baseline to the follow-up was found among those who reported an improvement in contact with superiors (OR 5.0, 95% confidence interval 3.0-8.4). When only the physical exposure factors were used in the stepwise logistic regression, reduced exposure for work in a twisted or bent posture was associated with absence of symptoms from shoulders at the follow-up (OR 3.5, 95% confidence interval 2.1-5.8).

**Table 7.** (Table 5 in article). Twelve-month prevalence of musculoskeletal symptoms among younger (<35 years) and older workers ( $\geq 35$  years) at baseline and at the follow-up (n = 82). The prevalence was calculated in percentage of delivered answers excluding dropouts.

Region	Age <35 years n = 51		Age $\geq 35$ years n = 31	
	Baseline	Follow-up	Baseline	Follow-up
Neck	39	23	48	45
Shoulders	54	29 <sup>1</sup>	46	43
Thoracic	35	17 <sup>2</sup>	21	17
Low-back	46	27 <sup>3</sup>	38	40

Notes. 1— $p = .003$ , 2— $p = .01$ , 3— $p = .04$ .

## DISCUSSION

There are two important findings of this thesis on postal work. The first, that there are significant associations between psychosocial factors at the workplace, i.e., psychological work demands, social support, skill discretion, and authority over decisions, and the prevalence of musculoskeletal, gastrointestinal, and sleep complaints. The second, that it is possible to reduce these complaints by changing the work organization and improving the psychosocial situation at the work place. These findings indicate that a key issue in the society's aim to reduce work-related disorders is to focus on the work organization rather than on single topics and exposures.

However, when interpreting epidemiological studies, aspects on validity must be taken into consideration, since a poor study design can invalidate the obtained results. The validity can be internal or external, i.e., the possibility to generalize the results to other populations than that under study. The internal validity is mostly discussed in terms of bias, chance, and confounding. Bias, or systematic errors have been divided into two categories: selection bias, observation (information) bias, but some also regard confounding as a systematic error (118).

### **Aspects on validity**

#### *Selection bias*

Study I was a cross-sectional study where 75% of the invited subjects took part in the questionnaire survey. There was no difference in the distribution of age and gender between responders and non-responders and no difference in age between full-time or part-time workers. Since the main objective of this study was to assess baseline values for a longitudinal study (study II) the persons excluded from this study were either those on short-term appointments or those about to leave work for various reasons, i.e., a new job or retirement. Although the participating rate for part-time working men was rather low (15 of 25, 60%), this probably would not bias the results since this encompassed a small part of the study group. Besides, the aim was not to determine the absolute numbers of psychosomatic complaints and psychosocial disturbances, but to explain the relationships between them. In that respect the distribution into different

exposure categories seems to have been adequate to make comparisons possible. There were no significant differences between men and women in any of the symptoms or exposure indices, aside from decision latitude where the women scored significantly lower than the men. Since there was a large proportion of women in the letter sorters group and no women among the supervisors, who had high decision latitude, the difference was interpreted as depending on work rather than gender and therefore men and women were analyzed together in the three-dimensional model. In study I, there could be a possible underestimation of an effect, if people with pronounced symptoms had left their jobs, while the healthy individuals were still at work. This selection bias might have distorted the results, resulting in underestimation of the impact of work upon sleep and gastrointestinal symptoms.

In study II, the non-responders were younger (mean age of the non-responders 30 years and the responders 35 years)<sup>2</sup>, more dissatisfied with the psychosocial work environment, and also scored higher for gastrointestinal complaints (mean 3.9 versus 3.2)<sup>3</sup> and sleep difficulties (mean 11.7 versus 10.9)<sup>3</sup>. The non-responders thus differed from the responders. The analyses of the impact of the organizational changes were performed only on those who answered at all three occasions. In that respect we don't think that selection bias have affected the result but the loss of subjects to follow-up could influence generalizability and lead to an underestimation of the impact of organizational changes on reporting of symptoms (see below).

In study III, by random sampling and including also all available postmasters/letter carrier superiors, we believe that the study group was a representative sample of the study population. Furthermore, the response rate was high (78%) and there were no differences in age between responders and non-responders. However, the response rate was significantly lower ( $p < .05$ ) among those to whom the questionnaires were mailed than in the two groups where they were distributed at the work place.

Study IV was a longitudinal study. Invited to participate were those who had completed a baseline questionnaire. Excluded from the study were persons on longer

<sup>2</sup> In the original article (study II), fig 1, the mean age of the non-respondents was erroneously computed. Here are the correct figures. The error did not, however, influence results of the study.

<sup>3</sup> These figures were not shown in the original article.

sick leaves at baseline. On the follow-up 11 persons (11%) had left work and 6 persons (6%) did not reply. The women had a higher response rate (89%) compared with the men (77%) but the groups were small. There were no differences in age between responders and non-responders. The selection between intervention and control groups was voluntary and could not be influenced by us. Those who chose to join the intervention group were younger (mean age 28 years versus 32 years), had worked in their current occupations shorter (median 2 years versus 4 years), and had less skill discretion than those who chose to join the control group. This might have positively influenced the possibilities of improvement in the intervention group but if so, it also emphasises one of the main results of the study – that organizational changes should be implemented early and before symptoms become chronic.

#### *Observation (Information) bias*

A cross-sectional design always inherits the possibility of observation bias since exposure and symptoms are assessed at the same time. The observation bias can be of different types, i.e., recall bias, interviewer bias, and misclassification. A follow-up study can be biased by the loss of persons to follow-up (118). Recall bias occurs if persons with a disease tend to remember exposure in a different way compared with healthy persons. Interviewer bias can occur if the interviewer has knowledge of the person's disease status and therefore penetrates the exposure history differently for sick and healthy persons. Misclassifications occur when persons are erroneously categorized with respect to either exposure or disease status (118), and can be either differential or non-differential. Differential misclassifications are especially problematic as both exposure and outcome are misclassified, leading to a bias of the true association either as overestimation or underestimation. A non-differential misclassification of exposure (or disease) leads to random distribution of the error between the study groups. Such a misclassification obscures the true difference between the examined groups and the relative risk is approaching one.

In study I and III, we used questionnaires to gather information and the answers might have been affected by recall bias since exposure and symptoms were assessed at the same time. However, since the individuals were not informed of the purpose of the

studies, i.e., to investigate a possible association between psychosocial work situation and complaints, we believe that a recall bias related to exposure status was less likely. A possible misclassification would therefore be non-differential, related to the reporting of psychosomatic and musculoskeletal complaints, which would have diluted the true effect of the exposure and resulted in a conservative risk estimate. Another source of information bias could be the contact between the investigators and the responders (interviewer bias). This is unlikely, however, since this contact was only for the purpose of delivering and collecting the questionnaires and the investigators did not intervene in the completion of the questionnaires.

In study II there was a loss of persons between baseline and the follow-up studies. The non-responders differed from the responders both with respect to exposure and symptoms. It is therefore likely that this caused a differential misclassification. The non-responders had both a worse psychosocial work situation and more symptoms than the responders. Since the aim of the organizational changes was to improve the psychosocial work situation, work schedules, and meal habits at the premises, it is probable that the non-responders had gained from them, which would imply that the misclassification might have had a diluting effect on the associations.

In study IV there was a small group of persons who refused to answer to follow-up (6 persons, 6%). In addition 11 persons had left work. There were small differences between responders and non-responders at baseline. Therefore, any important misclassification is less likely. In the observation studies, the same persons were studied and interviewed by the same observer at baseline and follow-up. That could imply a risk of interviewer bias. However, the observers were trained and experienced in their respective method, and they did only assess various aspects of the work environment but no symptoms. We therefore believe that observation bias did not distort the results of this study in a substantial way.

### *Confounding*

Confounders are risk factors for the outcome of interest and are associated with the exposure under study. In study I, possible confounders for gastrointestinal complaints and sleep difficulties could be smoking, snuff use, caffeine intake, medication, alcohol, marital status, age, and gender. In the analyses we only included age and gender. The reason for that was that the other possible confounders had been tested in an earlier pilot study at the same work place. In that pilot study, no associations were found between caffeine, medication, marital status, and symptoms, but there were more gastrointestinal complaints among tobacco users and more sleep difficulties among alcohol users. However, very low reported alcohol consumption in the work group makes the latter association doubtful (2). Younger persons reported more symptoms than older. In the analyses in study I and II there were no associations between working time or night shifts and reporting of symptoms. In study I smoking could be attributed part of the prevalence for gastrointestinal complaints but it is unlikely that smoking could influence the strong associations between psychosocial factors at work and symptoms, since only about 30% of postal sorters were smokers (4). Furthermore, it was not the aim of the study to assess the prevalence of symptoms. In the longitudinal study (study II) confounders played a smaller role since there is no reason to believe that confounders were changed in a non-random way during the follow-up period. Factors that could influence the results were the possibilities to have hot meals on a more regular basis and an improved shift system, but these changes were part of the intervention and can therefore not be regarded as confounders.

In study III and IV possible confounders for associations with musculoskeletal symptoms could be physical workload, age, gender, years in present work, and smoking habits. Therefore, all these factors were included in the analyses. In the intervention study, (study IV), there was no reason to believe that confounders should be changed in a non-random manner during the follow-up period.

We therefore don't think that confounders have distorted the results of the studies.



### *Generalizability*

All studies were performed among postal workers. This could affect the generalizability of the results. However, Hennekens and Buring (118) concluded that it is more difficult to select people randomly from the general population and draw conclusions from that, since such a selection is subject to increased risks of bias or confounding. They proposed instead to “restrict admissibility to individuals who are comparable with respect to other risk factors for the outcome of the study, as well as on whom complete and accurate information can be obtained”. Also Griffiths (119) pointed at the risk that focusing to maximize internal validity are often done at the expense of generalizability (external validity). She suggested more focusing upon macroprocesses (conceptualisation, design, and implementation), and microprocesses (change mediating mechanisms), as they are more generalizable than outcome. In case studies, such as study II and IV, the cases do not represent samples, but they are generalizable to theoretical propositions and not to populations (120). According to Griffiths’ suggestions, it might be that the restriction to postal workers does not reduce the generalizability of the studies, at least concerning the impacts of the macro- and microprocesses described.

The two longitudinal studies (study II and study IV) suffer from the lack of randomly selected control groups. In both studies, the individuals are compared with themselves at different times (baseline and follow-up). The relative comparisons with control groups could be problematic in organizational research (120), in case not only the “experimental”, but also the “comparison group” have high scores for symptoms, leading to underestimation for risk factors. In study IV there was a control group but it was not randomly assessed. In field studies in living organizations it is virtually impossible to assess random control groups when the effects of organizational changes are studied. The reason for that is obvious. A random selection of workers to intervention and control groups could reduce compliance. The risk is that individuals who want changes are selected into the control group and individuals who oppose changes are selected into the intervention group. This would probably lead to a negative reaction among most of the workers leading to a failure of the organizational changes (see also 119). In addition, when as in the present studies, one of the main

goals was to increase the workers influence on their own work situation, this strategy would be contra-productive and therefore impossible to perform. Consequently, no such studies have to our knowledge been published. Murphy (121) has proposed a standard for methodological quality. He proposed a rating from one (\*) to five stars (\*\*\*\*\*), varying from (\*): evidence that is descriptive, anecdotal or authoritative to (\*\*\*\*\*): evidence obtained from properly conducted study with a randomised control group. Kompier and Cooper (122) have proposed a minimum standard of (\*\*\*) for evaluation of organizational changes. The longitudinal studies in this thesis comply with this (122): study II (\*\*): evidence obtained without a control group or randomisation but with an evaluation. Study IV (\*\*\*\*): evidence obtained from properly conducted study with control group but without randomisation.

In the longitudinal studies, loss to follow-up could also reduce generalizability. This might be a problem in study II where the non-responders differed from the responders. We consider that this reduces the generalizability of the effects of organizational and psychosocial improvements on reporting psychosomatic symptoms but it is, as discussed under observation bias, more probable that the impact was diluted as a result of non-response than the opposite. In study IV, the impact of the organizational changes might have been smaller if it had been possible to include persons on longer sick leave, especially as several in that group probably had chronic musculoskeletal symptoms that would not benefit from the changes. This would not, however, change the conclusion that organizational changes can influence reporting of musculoskeletal symptoms before they have become chronic.

Generalizability (external validity) could also be strengthened (or reduced) by findings of other authors who have studied other work groups. This will be further elaborated in the next chapters.

### **Reliability of self reported symptoms and work environment**

Most of the information in the studies of this thesis was gathered from questionnaires, which were completed by the participants. An important issue, therefore, is if it is possible to obtain valid and reliable information about work situation and symptoms by such self-reports.

The questionnaire concerning job strain was validated earlier (123). It was found that the validity and internal homogeneity was high for the index psychological work demands and that the index for decision latitude (skill discretion and authority over decision) is well suited for population studies with large differences between works, but less suited for single workgroups. Especially authority over decisions had a low reliability. However, in study I, we made a reliability test on a fairly homogenous group of postal workers. In that, we found a higher reliability for psychological work demands and decision latitude than in the Stockholm MUSIC I study (123). We therefore think that the questionnaire can be used in studies on postal workers. Also the questionnaire concerning social support was earlier validated (124), and in study I we found acceptable reliability for the indices contact with superiors and team-mates. We used the same questionnaire as Theorell et al. (17) and Ahlberg-Hultén et al. (124). Ahlberg-Hultén et al., made a factor analysis on the 16 items, resulting in 5 factors. These differed somewhat from our findings, probably because their study group was female nursing personnel and in our group there were predominantly men. The reliability was acceptable for the indices used.

The questionnaires of the demands-control-support (DCS) model have been widely used (15, 16, 17, 18, 124, 125) and have been regarded as acceptable. A multilevel analysis (126) supported the model. Considering the widespread use of the demands-control-support (DCS) model and the good validation of the questionnaires we believe that it was appropriate to use them in the studies.

The questionnaire on sleep disorders has been introduced by Åkerstedt (38, 62) and has been used in other studies (15, 17) and was earlier validated (123). Theorell et al. (17) constructed the questionnaire used to assess gastrointestinal complaints. The questionnaires were not dichotomised and we used the total score of each index as dependent variable. That means that there was no sharp border between sick and healthy. This fact, and the obviously functional nature of the gastrointestinal symptoms, made an objective validation of the questionnaires impossible. We cannot, therefore, analyse the true prevalence of sleep disorders and gastrointestinal complaints in study I and II, but believe that the questionnaires were well suited for measure of the outcomes.

In study III and IV we used a questionnaire for physical load introduced by Marklund et al. (110) and the Nordic questionnaire for musculoskeletal disorders (111). The questionnaire for physical load was earlier factor analysed and reliability tested (127), the Cronbach's  $\alpha$  values were found to be acceptable. It was used to assess different aspects of physical workload during the last week and was chiefly used as a control. Earlier studies (128, 129) have shown good validity at the dichotomous level of self-reported physical load but too low agreement when duration or frequency was quantified. Contrary to that, Fredriksson et al. (130) concluded that questionnaire based information regarding an evaluation of a workplace intervention was found to be valid as regards to time spent in strenuous posture. Other authors (131, 132) also found acceptable test-retest reliability of a work history questionnaire and questionnaires on musculoskeletal disorders (131). Köster et al. (133) showed that retrospective assessments of exposure at the workplace showed misclassifications to a certain degree but that the influence of these on the risk estimates was limited. However, a structured interview has been shown to be superior to questionnaires in assessing retrospective exposure data (134). Some authors have discussed the risk for dependent misclassification of exposure by individuals with severe musculoskeletal symptoms (129,135). Other authors (136, 137) have found no such dependent misclassifications. In study IV, no improvements of the physical workload were implemented. This is mirrored in the answers to the questionnaire, which showed only minor, non-significant changes in physical workload during the follow-up year. This makes us believe that the questionnaire for the purpose of these studies was adequate.

The Nordic questionnaire for musculoskeletal disorders has been extensively used and is considered as a valid instrument. We used the 12-month's periodic prevalence for dependent variables. That it is possible to obtain valid information on musculoskeletal symptoms have been shown by e.g., Björkstén et al. (138).

## Observation methods

*AET-method “Arbeitswissenschaftliche Erhebungsverfahren zur Tätigkeitsanalyse“.*

This method was initially used in Germany to describe the general work content and demands (113). It is based on the concepts of stress and strain and the man-at-work system (139). 216 variables are assessed during observation and interview and are grouped into 39 sum items for the profile analysis (113, 139). Interobserver reliability has been tested with 75-89% uniform classifications of the items (139). We translated the AET-manual (Wahlstedt and Björkstén, unpublished report). The AET observer in study IV was very experienced in the method. Therefore we believe that the results of the measurements were reliable. AET had not been used to study changes in organization before, but the results of this study show that this method can be an important tool in that type of studies.

### *PLIBEL*

This method was invented by one of the co-authors of study IV (114) and she also performed all tests herself. This method is designed to assess the risk factors for the individual that is known from the literature to be harmful. The assessment is dichotomous (risk/no risk). The method was earlier validated and reliability tested (140). The results of this and the fact that the inventor used the method herself make us believe that the results obtained with PLIBEL were reliable (study IV).

## Comments on psychosocial work environment

The theoretical framework of this thesis is the demands-control-support (DCS) model (11, 18). This model focuses on the characteristics of jobs and psychosocial work environment in contrast to an earlier focusing upon a person-environment fit (PE) model (11). Theorell has recently pointed at the adverse impact that especially low decision latitude has on the regulation on endocrine parameters and health (141). However, Karasek's original measure of decision latitude (12) has been criticized for being a mix of job control, skill variety, and job complexity (142). The control aspect has been considered the crucial factor (142, 143) with active coping interacting

between job demands and job control (126, 143). De Jonge et al. (142) found that authority over decisions was a stronger predictor than skill discretion with respect to outcome measures (depression, psychosomatic symptoms, sick leave), and suggested that decision latitude should be divided into skill discretion and authority over decision. This is exactly the same division already used since a long time in many studies (see Theorell et. al., 16), and in all the studies of this thesis. When computing the three dimensional model, however, we used the decision latitude. The great differences in symptom ratings between differently exposed groups in study I and III, support our use of the three dimensional model, and multiple regression and logistic regression analyses with the aspects of the DCS model as independent variables instead of computing job strain (the quotient between psychological work demands and decision latitude. However, our use of dichotomised variables in the three dimensional model might dilute the true differences in symptom ratings since the difference between low and high exposure can be small, see also 125). This is further supported by de Jonge et al. (142) and de Rijk et al. (143) who did not find any interactions between demand-control as predicted by the DCS model, see also discussion in a previous chapter. In study II we found that contacts with superiors and team-mates were unstable during the follow-up period, and that contact with team-mates was the strongest predictor for outcome from one follow-up to the next. Authority over decisions and skill discretion, on the other hand, changed slower than social support and did not increase until the second follow-up. This shows the importance to study the three aspects of the DCS model separately and furthermore that the follow-up period must not be too short since all psychosocial factors do not seem to change simultaneously. The trend of increased skill discretion and authority over decisions seems to be the most important result of the intervention in study II, but more research with longer follow-up periods is needed to study how this trend can be stabilized and work control further increased or at least maintained on a higher level.

In study II the changes were in the direction towards an active work situation (increased demands and decision latitude) and in study IV towards a low strain work situation (reduced psychological work demands and unchanged or increased decision latitude). It appears that the reduction of symptoms was most evident in study IV,

while in study II -- on the group level -- the symptoms were unchanged, only those who reported an improved psychosocial situation at work had reduced complaints. This is in accordance with the model since a low strain work situation is considered to be better than an active one. However, in spite of the lack of symptom reduction in study II there was a significantly reduced sick leave, possibly related to the increased decision latitude.

In recent years Siegrist has proposed another theory of psychosocial work environment, the effort- reward imbalance model (144). That theory implies that a high degree of effort must be associated with increased reward, i.e., remuneration, increased self-esteem, and social status. According to this theory, high effort and low rewards lead to emotional distress and adverse health effects. The demand-control-support and effort-reward models were tested simultaneously in the Whitehall II study on cardiovascular risk factors (145, 146). Both lack of control and poor effort-reward balance were predictors of increased cardiovascular risk independent of possible confounders, such as smoking, hypertension, and elevated serum lipid levels (146, 147). Theorell (147) made an evaluation of the etiologic fraction (EF) for first myocardial infarction if effects of job strain, shift work, and effort-reward are independent and found it to be very high, "probably on the order of 20%". This implies that both the dominant models of psychosocial work environment should be considered in future research.

In a cross-sectional study of mail sorters, Amick and Celentano (148) found that a machine-paced technological system of work was associated with greater job demands, less work control, and less co-worker support. Supervisor support was the only job characteristic not determined by the technological system and it had the second strongest effect on psychosomatic symptoms (after job satisfaction) and they proposed that interventions should be directed to affect supervisor support (see also 26). These findings are supported by the results in the longitudinal studies where a positive change in the contact with superiors was associated with lowered ratings for sleep and gastrointestinal complaints, (study II) and a decrease in musculoskeletal symptoms (study IV).

Lean production i.e., an attempt to improve production through continuous improvement in productivity and quality, just-in-time system, elimination of wasted time, and quality circles, have been introduced throughout the industrialized world (149). It has been shown in the auto industry that this new type of production leads to increased work pace and demands, while decision latitude remains low, which has led to increases in musculoskeletal disorders (149). However, in one study, workers in a more flexible “sociotechnic” organization, providing higher decision latitude and longer cycle time than in assembly lines or lean production did not show increases in systolic blood pressure, heart rate, and adrenaline during the work shift, contrary to workers in traditional assembly line work (150). This pattern was most pronounced among female workers (150), which was hypothesized as depending of the females’ greater ability to cope with conflicts at work, more common in the flexible organization than in the assembly line work, and/or of the positive impact of a flexible organization on their possibilities to perform unpaid work at home (150). Work routinization has however been shown to be more negative for women than for men (151, 152). These studies support the findings of this thesis that the introduction of a flexible organization can significantly improve the health of the workers.

### **Comments on shift work**

In a review of models of shiftwork and health (153), “a change from focusing on circadian disruption as the main mediator between shift work and health to incorporating the important roles of psychological variables such as coping” was described. The authors concluded, “In many (though not all) ways, shift work can be thought of in the same way as any other job stressor”. The earlier finding that the biologic clock is set at 25 hours/day (35, 36) has been revised and has been shown to be closer to 24 hours/day (154). The earlier finding led to the recommendations (44, 48, 49, 55) to introduce forward rotating systems (morning-afternoon-night-day off). Recently, Tucker et al. (155, see also 62) showed few effects of direction of shift rotation upon chronic measures of health and well being, however, they and others (156) point at the need for enough time for recovery between shifts to avoid acute negative effects (e.g., duration of sleep). Permanent tolerance to shift work cannot be



acquired (42, 157) and therefore a rapid rotation of shifts seems to be better than weekly rotation (44, 157, 158). However, there is some evidence that a slower rotation (working at each shift for three weeks) can be superior to rapid rotation (158). Individuals with large amplitude circadian rhythms (e.g., in body temperature) tend to tolerate shift work better than persons with low amplitude (157, 159), shift workers with good tolerance have a circadian rhythm close to 24 hours (157), and older persons become increasingly more intolerant to shift work (43, 159, 160, 161), especially women (161). The increasing intolerance with age has been attributed increasing morningness and lowered amplitude of circadian rhythms (43, 159, 160).

In study II, the changes in the shift system were in the direction of a forward rapid rotation, considering the earlier findings on circadian rhythms. However, it might well be that the most important impact was the abandoning of early morning shifts, which had been shown to be troublesome (2, 158, 162), the longer free of work periods between shifts, and the reduced complexity of the shift system with meal breaks at approximately the same time on consecutive days, which are all consistent with current recommendations. In addition, it is plausible that more focus should be on individual tolerance to shift work (157), especially in an ageing working population (160).

## **Comments on psychosomatic disorders**

### *Gastrointestinal disorders*

In a recent update on functional gastrointestinal disorders, FGIDs, (functional gastrointestinal disorders, e.g., irritable bowel syndrome, IBS, and functional dyspepsia, FD) it was concluded that “psychological stress or emotional responses to stress can affect gastrointestinal function, and the effects of different emotions on the gastrointestinal tract are well established” (163). The research has shifted from a unidirectional relationship between psychosocial events (e.g., stress) and gastrointestinal function, to the reciprocal interaction of physiologic and psychosocial processes in these conditions (the brain-gut axis) (164, see also 74). No study has found a unique psychological profile or mechanism for symptom development (163).

Empirical evidence exists of a relationship between job strain and lack of social support on one hand and risk of illness (FGID) on the other (147). Prolactin plasma levels have been shown to be low among FD patients compared with healthy individuals (165), which strengthen the hypothesis of a dysregulation of brain-gut neuroenteric system as an explanation for FGIDs (164). In a study of 615 patients with FGID, patients felt less possibility to influence their working conditions (166); they were also more often shift workers (166, see also 159, 160). In IBS psychosocial factors influence the illness experience, and decision to seek medical care (167). The course of the illness is also affected by stress (167). The importance of psychosocial factors is also shown by the findings that psychotherapy, both psychodynamic and cognitive, is superior to conventional medical treatment for functional gastrointestinal disorders (74, 75, 163, 164).

Peptic ulcer has earlier been associated with psychological factors but after the recognition of *Helicobacter pylori* infections as the single most important risk factor for peptic ulcer the concept changed (168). However, only 20% of infected individuals (men) develop an ulcer (169). It has therefore been suggested that psychological and physical factors interact to induce ulcers, especially complicated ulcers and those not related to neither *H. pylori* nor nonsteroidal anti-inflammatory drugs (NSAIDs) (170). Shift work, and more generally lack of sleep, and irregular eating habits also seem to promote ulcer development, conceivably through effects on the HPA (hypothalamic-pituitary-adrenal) axis (170).

The findings in study I and II are supported by recent research (see also 73, 74), which shows a consistent relationship between psychosocial factors and FGIDs. In our studies no impact was found of age, gender, shift system or length of shifts, on reporting of symptoms. In study I low support from superiors, and high psychological work demands were associated with gastrointestinal complaints. The scores for gastrointestinal complaints did not differ before and after the follow-up period in study II, but changes of contact with superiors and team-mates, and change of skill discretion all influenced the reporting of gastrointestinal complaints at follow-up. Since gastrointestinal symptoms affect e.g., general health, social functioning, and absence from work (167) it is an important finding that changes of work organization

can affect such complaints. In the theoretical model (11), high decision latitude is suggested to compensate for high work demands, but in study I, a situation with high work demands, and high authority over decisions was associated with the highest frequency of gastrointestinal complaints, if social support was low (cf. 21).

### *Sleep disorders*

Sleep disturbances are common among shift workers after night shift (37, 39, 40, 41, 42, 43, 44, 171) and before early morning-shift (40, 158, 162) and increase with age (37, 41, 42, 43, 160, 161, 171).

At work, sleep difficulties are also constantly associated with physical work load (63, 172), psychosocial factors, e.g., visual display terminal (VDT) overload (173, 174), over-involvement in the job (173, 174), job strain (15), hectic work (57, 63, 172), working overtime (63), and inversely associated with social support at the workplace (172). In addition there are associations with psychiatric disorders (57, 61, 65, 175), alcohol use (171, 173), and physical disorders (60, 93). Sleep disorders are also associated with sick leave (176). Women report more sleep disorders than men in some studies (63) but not in others (64, 172). Cherry's findings (65) that there were no associations between stressful factors at work and sleep problems, might depend on that his cohort was community based, which might have diluted the effects of work since work exposure is very different for different individuals of the community.

In study I sleep quality index was significantly higher (worse) among individuals who reported high psychological work demands, unsatisfactory contacts with superiors, and unsatisfactory contact with team-mates. High job strain and an active work situation were associated with higher scores (worse) on the sleep quality index, especially if social support was low (cf. gastrointestinal complaints, and 21). As for gastrointestinal complaints, no associations were found with age, gender, shift system, and shift length. High psychological work demands, bad or worsened contact with superiors, bad or worsened contact with team-mates, female gender, and worsened skill discretion were associated with higher ratings in the follow-up study (study II). At follow-up 1 but not follow-up 2, significant association was found between attitudes to the performed changes and sleep difficulties. It seems probable that a positive attitude

to a change of organization is short living and that in the long run, it is the perceptions of the psychosocial work situation that are associated with symptom's ratings.

The results of our studies are in accordance with the findings of other authors (15, 57, 63, 172, 173, 174). Tachibana et al. 1996 (173, 174) did not, however, find any associations between social support at work and sleep disorders but their study was cross-sectional. The results from our studies and the findings of other authors show the importance of improvements of psychosocial work situation and shift system for the reduction of sleep problems, see also discussion in the previous chapter.

### **Comments on work-related musculoskeletal disorders**

During the last decades musculoskeletal disorders have been extensively studied because of the high prevalence and huge costs for sick leave. It has been concluded (177) that “work-related musculoskeletal disorders have high incidences and prevalences among workers exposed to manual handling, repetitive and static work, vibrations, and poor psychological and social conditions”. Kemmlert et al. (178) found a poor prognosis after occupational over-exertion injuries, however, a good social support at work was associated with a better prognosis. The need for regulatory action against work-related musculoskeletal disorders has been proposed (177, 179, 180). Evaluation of existing regulations is however almost lacking (180). Regulations are also difficult to realize since the mechanisms that lead to musculoskeletal disorders are still not known in detail (179, 180) and more high quality research is therefore needed, especially longitudinally designed (181, 182). A multidisciplinary approach to the problem has been proposed (181, 183). Yassi (184), pointed at the crucial role of physicians to engage in the early recognition of problems and to stimulate work-place ergonomic interventions. The differences between occupations should also be considered (185). In a study on municipal employees, Nygård et al. (185) found high musculoskeletal load among workers in installation, auxiliary, home care, and transport compared with administration personnel. The difference was greater among older employees, which implies special concern for ageing workers (183, 185). Among postal employees, a high frequency of musculoskeletal complaints has been reported (186, 187) and the prevalence remains high many years after cessation of exposure

(187). This is an important finding that supports the results of study IV, that the effects of the psychosocial interventions at work did not have any effects on the older workers but a strong effect among younger workers, which further implies the need for early interventions to reduce musculoskeletal symptoms.

In the last decade, more interest has been on psychosocial factors and their relations to musculoskeletal disorders (11, 17, 83, 84, 88, 89, 90, 91, 92, 93, 124, 147, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198). Lundberg (193), found that mental stress increased the muscle tension, recorded with EMG, in the trapezius muscle. Stress induced by psychosocial stress at work is usually more lasting than that resulting from physical demands, which reduces the time for rest and recovery leading to a longer lasting physiological activation and risk for injury (193, cf. 86). Theorell et al. (17) also found that muscle tension was strongly related to back, neck, and shoulder symptoms. Pain in the neck-shoulder region has been found in persons with a very low EMG-activity in the trapezius muscle (199, cf. 193) and it has been proposed that physical workload, stress, and individual sensitivity independently increase the risk for pain in the neck and shoulders (199). In a recent review, Linton (197) concluded that psychological factors play a significant role for chronic pain and in the transition from acute to chronic pain. In study IV, a psychosocial improvement was also associated with reduced musculoskeletal symptoms, which might imply that the changes could counteract, or at least delay the chronic condition. In a recent experimental study (200), type A behavior (characterized e.g., by extreme competitiveness, ambition, impatience, irritability, hostility) was associated with much more antagonistic activity during controlled elbow tasks. This might increase the risk of type A individuals to develop musculoskeletal disorders. However, research has found (84, 88, 188, 195, 196, 197), that psychological variables were only associated with part of the multidimensional spectrum of neck- and back pain. Furthermore, associations between psychosocial work conditions are found mainly in the central body regions (190) (neck, shoulder, back). Consequently, as we were mostly interested in the psychosocial impact on musculoskeletal symptoms, the outcome measures in study III and study IV were restricted to those regions.

Life-style factors have been associated with musculoskeletal problems. Barnekow-Bergkvist et al. (201) found in a 18 years' follow-up study of students an inverse relationship between performance in certain fitness tests at the ages of 16 and 34 and musculoskeletal symptoms. This implies the need for fitness training at an early age. However, exercise programmes among workers have had no or relatively small effects on symptoms (102, 202, 203, 204). Active leisure decreased the risk for disorders from the upper body in one study but physical tasks influenced musculoskeletal disorders more (205). Individual factors as age, gender, body length, body weight, strength, smoking have in some studies been associated with low-back pain but in most studies no such associations were found (206, 207). On the other hand, personality traits and emotional problems have been associated with back trouble (cf. 89).

Job strain (208), low quality of job content (209), low job control (208, 209, 210), emotional distress and poor coping capacity (208), musculoskeletal symptoms last year (176, 211), and earlier number of sick leave days (176, 178, 209, 211), have been found to predict sick leave for musculoskeletal disorders. These findings support the hypotheses that the organizational changes implicated in study II and IV were important measures to reduce costs and increase well being. In addition, measures to increase coping ability might be integrated in the treatment of musculoskeletal pain, e.g., by cognitive behavioural interventions (208).

### *Neck and shoulder symptoms*

Armstrong et al. proposed a conceptual model for work-related neck and upper-limb disorders (212). It suggests that exposure from work produces doses, which disturb the internal state of the individual, which results in responses that can be mediated by individual capacity. The model characterizes the muscular response as a series of cascading mechanical and physiological events. The response can be seen as another dose that may improve or decrease individual capacity. The level, duration, and frequency of the loads as well as the adequacy of recovery time, are crucial factors that determine if dose tolerance increases (training effect) or decreases which might produce a musculoskeletal disorder. In a recent review of physical risk factors (213)

some evidence was found for a positive relationship between neck pain and neck flexion, arm force, arm posture, duration of sitting, twisting or bending of the trunk, hand-arm vibration, and workplace design, but the methodological quality of most of the studies was considered to be low. Repetitive work was in another review (198) associated with neck pain. Warren et al. found similar results in a case-control study (214). They also found consistent associations between high psychological demands and low organizational support (i.e., supervisor support) and symptoms, but associations with decision latitude were weaker (214) which is similar to the findings of Toomingas et al. (190). Skov et al. (215), however, found a significant association between the combination of low control over time and high competition, and neck symptoms among salespeople. Warren et al. (214) found that increased decision latitude was protective for women but not for men. Contrary to that, Björkstén et al. (216) in a study on blue-collar workers and Barnekow-Bergkvist et al. (201) in a general population found that a higher decision latitude among women was associated with more neck symptoms which implies the question if the association between work control and symptoms differ between men and women. This finding could also have alternative explanations, e.g., in a study of burnout among intensive care nurses (143), active coping moderated the interaction between job demands and job control, whereas in nurses low in active coping, high work control increased emotional exhaustion. No gender differences were found in that study. In study III, we found no associations between low decision latitude and neck pain but low skill discretion was associated with pain in the low back among women. Most of these studies were cross-sectional (143, 190, 201, 214, 215, 216, and study III) which reduces the possibilities to draw aetiological conclusions. In the intervention study (study IV), however, authority over decisions was a strong determinant for symptoms from upper body at follow-up (cf. 189: in that study decision latitude was found to be an effective modifier, but only if combined with high levels of social support), which implies that work control might have a crucial function in the prevention of musculoskeletal disorders. Low decision latitude has also been associated with a low pain threshold during psychological stress, especially among those also reporting a high degree of sleep disturbance (93). This implies that the increase of decision latitude might be even more important among

shift workers. Theorell et al. (93) also found that if decision latitude was high, high psychological work demands was associated with elevated pain threshold, which could be a risk factor for musculoskeletal disorders. Thus, the combined effect of reducing psychological work load, if too high, and increasing decision latitude should be considered in interventions aiming at improving work conditions. This was also part of the change strategies of both study II and study IV.

Several authors report associations between low social support and neck problems (83, 190, 214, see also 189). This is in accordance with the findings in both study III and study IV. The results of study IV imply that an improved supervisor support is especially beneficial for symptom reduction (see also 148, 189, 214) and in study III significant associations were found between unsatisfactory contacts with team-mates and neck pain.

In a review on shoulder pain (217) consistent positive associations with symptoms were found for repetitive movements, vibration, duration of employment, and to a lesser extent, job dissatisfaction, and job control. Buckle (218) found similar associations with disorders in the neck, shoulders, and upper limb. Although the strongest relationships have been found between physical factors and symptoms, it is suggested that a balanced study should explore psychosocial exposures and individual factors as well (214, 217, 218, 219, 220, 221).

A shift to more varied tasks has been found effective in a female group (82), and special attention to the work conditions have been proposed for women and immigrants in preventive interventions (220). An overall reduction of physical workload is also demonstrated for men after introduction of job rotation (222). A reduction of data entry work in a female group was shown to be associated with reduced neck-and shoulder pain in spite of unchanged muscular load. This was attributed to more varied work tasks (223) but there were also some improvements of work organization (224).

To summarize, there seems to be a consensus that neck problems are associated with both physical and psychosocial factors at work which is supported by the findings in study III, and that organizational interventions should be attempted to reduce the prevalence for neck disorders. This is supported by the results of study IV, where a



predominantly psychosocial intervention was associated with a decrease in prevalence in neck problems.

### *Low-back pain*

In recent reviews, there were found consistent associations between lifting or carrying loads, whole-body vibration, awkward work postures and low-back symptoms (198, 225). Psychosocial risk factors associated with low-back pain were job dissatisfaction, job strain, social support from superiors, and team-mates (198, 225) but these associations were less consistent and there were a number of studies that showed no associations at all between psychosocial factors at work and low-back problems (198, 225). The lack of association could imply that no associations were at hand but also on selection, misclassification or interaction effects (198, 225). Burdorf and Sorock (225) pointed at four reasons that could lead to inconclusive results: 1. Small sample size. 2. Lack of exposure variability. 3. Presence of another risk factor or confounder. 4. Non-differential measurement error. Study IV had a small sample but nevertheless some associations were found. No association was, however, found between the reduced psychological work demands and symptoms, probably because of an absence in contrast for this variable between the two workgroups studied, i.e., almost all workers experienced a change of psychological work demands in the same direction. Additionally, no association was found between change in physical factors and symptoms in the logistic regression analysis with both physical and psychosocial indices as independent variables but in the analysis excluding psychosocial factors, working in a twisted or bent posture was significantly associated with symptoms. It is probable that this was a true effect but that it became insignificant after adjustment for the stronger predictor contact with superiors. Burdorf and Sorock (225) commented that studies on work-related risk factors for back disorders that show a decrease in the occurrence of back disorders after ergonomic improvements were very scarce. In study IV, we found such a decrease, which could be attributed to changes of work-related factors, which implies proof of reversibility (225) of musculoskeletal symptoms.

Psychosocial factors have been argued to be the best predictors of chronicity (226) and in a 10 year follow-up study it was found that social relations (i.e.,

supervisor support) and work content (i.e., skill discretion) scores predicted the changes in low-back pain independently of physical work load and socio-demographic factors (227). In a 24-year's nested case-control analysis (228) it was found positive associations between social support and low-back pain among men and between low influence over work conditions and low-back pain among women. In combinations with physical risk factors, this seems to be of high relevance for the occurrence of low-back pain. These findings (226, 227, 228) support the importance of the results of study IV. Concerning care seeking for low-back pain, social support at work did not have any influence at all in one study (229). For care-seeking, psychosocial factors alone seemed to be of less importance for women, while poor job satisfaction and mostly routine work without possibilities to learn increased the risk among men (229).

### **Comments on intervention in work organization**

Why are organizational interventions at the workplaces necessary? Theorell (1997, 230) has pointed at different future scenarios for blue-collar and white-collar workers: white-collar workers will have higher psychological work demands which are partly compensated by increased decision latitude, while blue-collar workers with a low educational level will face decreasing decision latitude, because their employment will increasingly be of short duration, and this group will move towards the iso-strain situation (isolation, excessive demands, lack of decision latitude), (see also 149). In a review of the rationalisation movement, Björkman (231) remarked that the Tayloristic (also called Fordistic) way of production was gradually abandoned in the post-war era. In the 1990s however, lean production was introduced (149, 231). Björkman (231) argued that this led to a revival of (modified, e.g., through application of job rotation and the adaptations to that job rotation) Taylorism with even shorter work cycles than ever before. Björkman (231) studied Time Based Management (TBM), in which assembly line work and short work cycles are reduced or preferably abandoned. This type of work organization has been promisingly adopted by ABB/Sweden (231) and is similar to the organization model studied by Melin et al. (150). However, Björkman (231) concluded that proof from the worksites for the positive impact of TBM on workers health are lacking, and we still know too little of how organizational changes

could reduce musculoskeletal symptoms, and that “there is no shortage of research issues in the interaction between organizational change and ergonomics”.

Levi et al. (1999) (232) concluded that work can cause stress and stress can contribute to a wide variety of ill health and decreased well being. They addressed the Resolution of the European Parliament of February 25, 1999: it states e.g., that work must be adapted to people’s abilities and needs and not vice versa; urges the commission to investigate in new work problems (i.e., stress, burnout); notes that musculoskeletal diseases and psychosocial factors constitute the greatest modern threat to workers’ health; draws attention to the problems resulting from a lack of autonomy at the workplace, monotonous and repetitive work, and work with a narrow variety of content. Levi et al. (232) also addressed the Tokyo Declaration (233), which expresses the need for multinational attention to job stress. The need for urgent changes are mirrored by the rapidly increasing stress and stress-related disorders in the industrialized world (233) and by the fact that psychological distress predicts disability in various diseases (e.g., myocardial infarction, depression, and musculoskeletal disorders) (234, see also 226).

That organizational changes at the workplaces are needed has been known for a long time (see 11). Karasek discussed recently (235) the need for change today and the obstructive forces to implementation of a “work quality approach”. He stated that, taken together, the market-oriented policy and the welfare-state model have “a global policy tool kit insufficient for the present challenge”. He further discussed four dilemmas, not enough considered. 1. An increasingly educated workforce has works that don’t use their full resources: “a work-stupidification” problem (see also 236). 2. Exhaustion, as result of overwork, and job insecurity from fear of unemployment are rapidly growing problems, which cause economic costs that are overlooked in current economic models. 3. Much of the productive output of services goes undetected by the market. In addition, most areas of social concern (activation, engagement, competence building, social and mental well being, work related illness, and family and community stability) are not based on conventional material output of a mass-production based economic platform. 4. The very existence of democracy can be

threatened by more and more persons working in passive job situations with deteriorating engagement in society.

Armenakis and Bedeian (237) in a review of the organizational research in the 1990s concluded that the change process typically occurs in multiple steps that take a considerable amount of time, efforts to bypass steps lead seldom to satisfactory results, and mistakes in any step can slow implementation, as well as negate hard-won progress. They suggest that future studies should evaluate content, contextual and process issues in longitudinal studies in order to make predictions how and why organizations change. Armenakis and Bedeian's (1999, 237) view is similar to the propositions by Karasek and Theorell 1990 (11) and Griffiths (119). Theorell (147) also pointed at the importance of information to different groups of actors before and during the process, introduction of group feedback, and discussion. Individual stress prevention and mental preparation for conflicting opinions about solutions are also important (147).

To summarize, there are consistent scientific evidence that worker's health need improvement of work organization, but that there are few examples of successful interventions in the scientific literature.

Consequently, Kompier et al. (120, 122, 238, 239, see also 24), in recent reviews, found only a few studies of changes in work organizations that complied with four stars rating (\*\*\*\*) according to Murphy 1996 (121). Kompier et al. (238), found that the scientific literature on stress management was disproportionally concentrating on reducing the effects of stress, rather than reducing the presence of stressors at work. They (238, see also 105) proposed 5 measures for successful implementing of stress-reducing organizational changes: 1. A stepwise and systematic approach. 2. An adequate diagnosis or risk analysis. 3. A combination of work-directed and worker-directed measures. 4. A participative approach, and 5. Top management support. Of these 5 measures, all but the third were considered in the longitudinal studies (study II and study IV), as we chose to concentrate on change of work organization instead of individual stress management programs. In study II, a systematic approach was taken through a pilot study of shift working men, which led to the risk analysis. A steering group was established with representatives from top management, unions, local

management, and researchers (myself). This steering group had several meetings during the change process where the progress could be discussed and measures modified (e.g., the proposed shift-rotating scheme was changed for one work-group because of opposition to it). The workers were invited to discuss the changes at meetings at the work place that were introduced as part of the changes. In study IV a steering group performed the risk analysis and propositions for change before the research was planned. Our role as researchers therefore was to evaluate the performed changes and not to participate in the change process. Also this study had a participative approach (cf. 25, 177, 183) since the workers could decide at which plant they would like to work and they had more possibilities to discuss with each other in a new team organization. In spite of obvious methodological problems, Kompier et al. (120, 122, 238, 239) found that the positive outcomes that they found in their reviews largely could be attributed to the intervention programmes, which are consistent with our results. Lökk and Arnetz (240), in a study of an organizational change in geriatric care, found no (anticipated) negative psychosocial effects but by offering a structured intervention program to one group of health care personnel, there were some positive psychosocial effects. This supports the suggestion by Kompier et al. (238) that work-directed and worker-directed approaches should be applied simultaneously. The importance of this finding is further supported by Hedin (241) who found among women in home care work that perception of a less positive work climate may be connected to a higher frequency of complaints, e.g., musculoskeletal complaints.

A change of organization could also reduce a deterioration of work conditions. In an intervention study of postal workers, aiming at increasing the employees' learning opportunity and decision latitude, Mikkelsen and Saksvik (242) found in the control groups deteriorating work conditions. In one intervention group this negative trend was reduced but not in another, probably due to organizational restructuring and turbulence in that group.

It is important to consider psychosocial as well as physical work situation when studying work organization (221). This is highlighted in a study of Christmansson et al. (243) of an organizational change in an automobile plant aimed to increase productivity and decrease musculoskeletal complaints. The redesign was towards more

varied, less repetitive, and more autonomous assembly jobs. However, though influence on and control of work was improved, none of the goals were fulfilled, in fact worker efficiency decreased, and musculoskeletal complaints increased. This was interpreted as a result of deteriorated social support and that the workers did not have enough skills for the more varied work tasks (243). This can be compared with the findings in study IV, in which improved social support from superiors was associated with reduced musculoskeletal complaints.

In the longitudinal studies of this thesis (study II and study IV) the outcome measures must be possible to obtain in a rather short time, have a consistent association with work stress from other studies, they must be at least theoretically reversible conditions, and be quite common in a working population. Obviously, it was not possible to use cardiovascular morbidity for that purpose though it is the most common outcome measure when evaluating the impact of psychosocial stress at the workplace, since it takes a long time to develop, is fairly uncommon in a working population, and can hardly be regarded as reversible. Therefore, the chosen outcome measures were gastrointestinal complaints; sleep quality, and musculoskeletal complaints. Furthermore, it was not sufficient to look at the exposure at one point only since the intervention aimed at changing the exposure. Consequently, in both studies we compared changes in exposure variables with changes in the outcome variables in addition to assess more conventional analyses e.g., exposure vs. outcome at several occasions (see also 244). In study II one outcome measure was also sick leave that decreased during the intervention period. We believe that this reduction was associated with the intervention since no reduction in sick leave was found in Sweden Post and in the general society during that period. Vahtera et al. (244) found in a population study that lowered job control predicted subsequent sick leave. It seems probable that the opposite could be the result of increased job control, as in our studies. Further elaboration of the data in study IV (245) showed that sick leave was reduced. However, we did not analyse that further, since during that period there was a great recession in Sweden leading among other things to a dramatic decrease in sick leave in the general society. We therefore could not analyse if the reduction in sick leave was correlated to improvements in the work environment.

In study IV, most implementations were aimed at improving the psychosocial work environment. Laitinen et al. (246) studied an organizational change where the changes were mostly technical. They found that also the psychosocial work environment was reported to be improved. Thus, it seems as if a desirable improvement of work might be assessed by quite different approaches. As in study IV, Laitinen et al. (246) found significant reductions in sick leave. Those were greater than in the whole industry in Finland during the same time (their study was however, as study IV, performed during a recession period).

### **The concept of coping**

Active (positive) coping means that the individual expects that he or she will be able to handle a situation with a positive result (247). If this is the case, there is a low level of subjective health complaints (248). If, on the contrary, as in regressive coping, there is expectancy that there is no relationship between available responses and the environment, helplessness is the result (34, 247), which in turn can lead to illness (e.g., 22, 221). Hopelessness is when the individual has established negative outcome expectancy, i.e., all available responses are associated with a negative outcome (247). Antonovsky (249) has focused upon those who don't get ill even in bad circumstances. He has pointed at the importance of coherence, i.e., intelligibility, manageability, and meaningfulness (249). A high sense of coherence was suggested to be associated with better coping and health. Research (e.g., 251, 252) has given support to that assumption. Bowman (252) also found that people from various cultures might attain a similar level of a sense of coherence, despite great socio-economic differences. Active coping has been found to reduce the negative impact of job strain (143). Maladaptive responses to job stress (i.e., regressive coping) could be disengagement, suppression of competing activities (253), and sick leave (208) but is influenced by work social support (253). In both intervention studies (study II and IV) attempts were performed to increase team coherence and possibilities to attain social support in order to enhance coping. This could be further influenced by feedback (25). In this thesis, (study II and IV), no group feedback was given, but possibilities to talk with fellow workers and superiors were increased. In study IV, those who had musculoskeletal symptoms at

baseline and were symptomless at follow-up had significantly higher authority over decisions at baseline. This could be an expression of a higher capacity in active coping among those who had a positive outcome.

Another way of influencing stress at work is by stress management programs. That such programs can be effective has been shown (121, 254, 255) but they are not considered as effective to maintain the benefits assessed, if not also organizational stressors are reduced (121, 254, 255).

### **Comments on postal work**

During the last 50 years there has been a dramatic increase in the proportion of women in postal work, both in Sweden (256) and in the US (257). In Sweden, the first female letter carriers were employed in the 1950s (256), and the number of women increased progressively to about 1990, thereafter the trend is declining (256). The occupational injuries have been reported to be different for men and women. For letter carriers and letter sorting machine clerks, the women had more injuries during their first year at work than the men (257), but in mail handling, women had more injuries after the first year of employment (257). The authors (257) had no explanation to this finding but hypothesized that a mismatch between women's physiologic capacity and the demands of jobs designed for men could be at least part of the explanation. Similarly, Christenson (256) hypothesized that the reduction of women in letter carrying depend on the new requisites in the team letter carrying, that was introduced in the beginning of the 1990s. The reason could be that the women, with their lesser muscle strength, need more support than the men and therefore become less popular as team-mates, additionally the increases in group advertisements have made the work heavier and more monotonous. On the other hand, Northcott et al. (258) found very small differences between men and women working as letter carriers and letter sorters, however, the differences between jobs were considerable and they therefore concluded that job, not gender determine perceptions of and reactions to work (258), which is similar to earlier findings (27). Cahill and Landsbergis also found high job strain among mail handlers (259). It was somewhat larger among women but the authors concluded that "the work environment – particularly physical hazards, the physical



environment, low decision latitude, job demands, and respectful supervision – are more important predictors of physical and psychological strain than demographic characteristics of employees”. In our studies, the gender differences were rather small which supports the findings of those studies (258, 259). In the scientific literature it is found that letter carrying, letter sorting, and mail handling are physically demanding tasks (1, 3, 4, 5, 6, 7 8, 95, 256, 257, 258, 259) and are jobs with risks of job strain (1, 2, 4, 6, 27, 94, 95, 256, 259, 260). In one study (260), it was demonstrated a higher moderating effect on demands by personal factors (i.e., coping) than by decision latitude, but in a large-scale, randomised, controlled trial of an educational program to prevent work associated low back injury among postal workers no positive effect of an effort similar to back schools (261) was found. These findings support that organizational changes and follow-ups of implemented changes are very important. In the follow-up a useful tool could be “The Work Environment Round”, developed for Sweden Post by Knave et al. (262, 263, 264).

## CONCLUSIONS

In general, the findings in this thesis support the demands-control-support (DCS) model proposed by Karasek and Theorell. It is a relatively simple theory, well suited for preventive practical work and field studies. However, we failed to confirm the statement that high decision latitude counteracts the negative impact of high psychological workload. In the studies, we found that result only if the social support was at an acceptable level. When, on the other hand, social support was low, the combination of high psychological demands and high decision latitude was associated by very high ratings for symptoms, both psychosomatic and musculoskeletal (cf. 21). Our results therefore suggest a greater modifying effect by social support than Karasek and Theorell did in their original model.

The results of this thesis show that it is possible to improve the health of the workers by changing the organization of work towards a situation with reasonable psychological work demands, improving of skill discretion, and authority over decision. As indicated above, improvements should also be directed towards social support since contact with superiors and team-mates are very important factors in the workers perception of health. Not only symptoms can be reduced by a careful improvement of work organization but also sick leave and staff turnover. The follow-up period needs to be of sufficient length (at least one year) for the evaluation of the impact, since it takes a different amount of time to affect different psychosocial work factors.

There should be few reasons for the enterprises not to consider these findings as improvement of work organization might reduce costs for replacing staff and introduction of new staff members, and it should be a challenge for the occupational health team to support the workplaces during the process of change.

However, in a situation with a good supply of workers, e.g., unemployment, it might be tempting, especially concerning low skill jobs, to focus on profit and not on workers health, since the work force is easy to replace with healthy individuals. For that reason, regulatory action on a political level might be necessary.

In the improvement of work organization, the stress models (DCS model and effort-reward model) should be used as guidelines rather than the predominating

managerial models (lean production, Tayloristic model), which have been shown to lead to deteriorating of workers health.

In the performing of organizational changes it is crucial to attain support from top and local management, union representatives, and staff members. A participatory approach is essential for a positive outcome.

Below are the conclusions concerning each of the studies of the thesis. The numbers refer to the aims of the thesis, described at page 18:

1. Psychosocial work situation, especially social support and high work demands are associated with gastrointestinal and sleep problems.
2. Changes in the psychosocial work situation are associated with changes in the frequency of reported gastrointestinal and sleep complaints. In addition an improvement of the psychosocial work situation can reduce sick leave.
3. Psychosocial work factors, especially social support, skill discretion, and psychological work demands, are associated with the reporting of musculoskeletal symptoms.
4. It is possible to reduce the frequency of reported musculoskeletal symptoms by changing work organization aiming at increasing decision latitude for the workers. In addition a positive contact with superiors is very important for a successful implementation of changes of the work organization.

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