Psychosocial work environment and sickness absence

A two-year follow-up on the IPAW study

Martin Lindhardt Nielsen

PhD Thesis

University of Copenhagen
Faculty of Health Sciences
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Abbreviations
BMI: Body mass index (weight in kg divided by squared height in m^2)
CI: Confidence interval
EF: Etiologic fraction
IPAW: Intervention Project on Absence and Well-being
Log: Logarithm
NIOH/NRCWE: National Institute of Occupational Health
(from October 2006: National Research Centre for the Working Environment)
OR: Odds ratio
RR: Rate ratio
RTW: Return to work
SES: Socio-economic status
SOC: Sense of Coherence

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Preface

At the 1995 Annual meeting of the Danish Society of Occupational and Environmental Medicine, I talked to Tage Søndergaard Kristensen, who I had met as supervisor on another project during my medical education. He was approached by physicians from 3 Occupational health services, because a number of workplaces suspected the psychosocial working environment to contribute to a high level of sickness absence. As research-based evidence was limited, they had agreed to initiate an intervention project to test if efforts to improve the psychosocial working environment could improve well-being and reduce absence. Tage asked me to participate, and after a short time we started to prepare the project in a number of very enthusiastic meetings in Tage's office at the Danish National Institute of Occupational Health (NIOH), with spirited discussions and laughing so loud that the work in neighbouring offices was disrupted.

During 1995, we prepared questionnaires and funding applications, and monitoring groups were established in the 3 organisations and started to prepare selection of workplaces and contacts to consultants to support the intervention workplaces. From the start of 1996, I worked full-time at NIOH. As in many other projects, the tasks showed up to be more comprehensive and take more time than expected. Applications for funding, for the ethics committee and the data authority; selection and preparation of workplaces to participate; editing, printing and mailing questionnaires; reminder procedures; coding and cleaning of data; analyses and detailed feed-back reports and oral presentation to the workplaces; workplaces that considered or decided to stop participation or were closed during the project period; waning enthusiasm and response percentages during the follow-up period; retrieval of the promised absence data and coupling them with questionnaire data – just to mention a few. Observational data were ready for analyses before the intervention data, and this determined the focus of the present articles and thereby the thesis.

Occupational research has its own occupational hazards; one being pre-occupation with the subject. The 5 articles were published 2002-7, interspersed with a clinical career. Now, the thesis is finally completed and is hereby proudly presented.

Thanks

I want to thank Tage Søndergaard Kristensen, Anders Ingeman, Hans Klausen and Klaus Stagis for inviting me to work on the project and for their comprehensive efforts to establish and support the project, and for all the knowledge, experience and support they have provided.

Thanks to Tage Søndergaard Kristensen, Jakob Bjørner and Reiner Rugulies for the countless aspects of advice and supervision I have received.

Thanks to Lars Smith-Hansen for all the very diverse tasks handled so meticulously during all the years at NIOH, from questionnaire logistics to data management, documentation and much more.

Thanks to Karl Bang Christensen, who is the main author of article 5, for statistical analyses and advice on articles 2-5.

Thanks to the many secretaries, student assistants and librarians who helped with so many different things through the years.

Besides the close collaboration with the colleagues mentioned above, many others have provided valuable inspiration, advice and constructive discussions. I want to thank the colleagues at the departments of epidemiology, work psychology and sociology, and not least the colleagues in the

research group on sickness absence, who provided both a boost in research on work environment and sickness absence, and a particularly warm and enthusiastic social framework around the work. And thanks to my colleagues at the department of Occupational Medicine, Hillerød Hospital, who supported me during the last phases of writing.

Thanks to the many participants for answering the questionnaires and taking part in project activities. Thanks to the 3 organisations for "letting us in", for organising local project committees and activities, supplying consultants for intervention workplaces, and for the time and resources spent on project activities.

Thanks to NIOH for hosting the project and me, and for economical and practical support. And thanks to the department of Occupational Medicine, Hillerød Hospital, for giving me time off to finish the thesis, and to the present department of Occupational and Environmental Medicine, Bispebjerg Hospital, for supporting the printing of the thesis.

The funding of the project is described on page 39. Thanks to the funds for the money that made the whole project possible.

Because of the trans-disciplinary subject, I proposed a psychologist, a sociologist and a physician to evaluate the thesis. Thanks to Kerstin Ekberg, Lars Iversen and Jens Peter Bonde for constructive criticism and positive comments in their written evaluation.

On a personal note, thanks to my wonderful children Astrid and Rasmus for your love and for your patience when the project kept my attention away from you. And to good friends, who encouraged me along the way, not least to Julie Gehl, who kept up the confidence to make it during difficult times and who also provides the setting for celebration in the end.

September 2010

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Summary

This PhD thesis summarises the results of the Intervention Project on Absence and Well-being (IPAW) that took place during my appointment at the Danish National Institute of Occupational Health (NIOH)(from October 2006: National Research Centre for the Working Environment, NRCWE).

Aims of the PhD were:
1. To establish the cohort, develop a relevant questionnaire, collect data, and test the psychometric properties of the psychosocial work environment scales, including two newly developed scales on meaning of work and predictability at work (article 1)
2. To analyze the impact of the psychosocial work environment on numbers of sickness absence days (article 2), short and long spells of absence (article 4), and to calculate etiologic fractions, as a measure of preventable absence (article 3).
3. To compare associations between psychosocial factors and absence when the psychosocial work environment is measured on the individual level and the workplace level respectively (article 5).

Methods: IPAW was established in co-operation between workplaces in 3 organisations, their occupational health services, and the research group. 52 workplaces with 2730 employees were recruited and employers' absence records retrieved for 24 months from answering the baseline questionnaire that included a wide range of possible predictors and confounders. Cronbach's alpha was used to test the scales and Spearman correlations for the descriptive statistics in article 1. Statistics further included Poisson regression with a scale parameter to take care of over-dispersion and an off-set variable to take care of limited follow-up time in article 2 and 3, and a multi-level Poisson regression in article 5. Etiologic fractions in article 4 were based on adjusted rate ratios.

Results: In summary, preventable factors in working environment and health related behaviour seem to explain substantial parts of absence from work. Six of the seven psychosocial scales predicted at least one absence measure – including the two new scales on predictability and meaning. Together, the psychosocial work environment factors predicted 29% of all absence days in the fully adjusted model. Decision authority was the most prominent predictor, in line with previous findings. Results for the other scales varied considerably between the genders, and between absence measures. Adjusting for health related behaviours generally had limited impact on the associations with psychosocial factors. Physical work environment had a more pronounced effect on the absence, and adjusting caused a more substantial reduction of associations with psychosocial factors. Adjusting for sense of coherence did not substantially change the results. When adjusting for socioeconomic status for comparison, associations with the psychosocial work environment scales were weakened, but not eliminated.

Perspectives: The best-documented psychosocial risk factors should be included in preventive measures to reduce unnecessary absence. And the dominant trend of observational research should be changed into intervention research to evaluate the effect of reducing suspected risk factors, and thus strengthen the knowledge base for prevention.

Dansk resume (summary in Danish)

Psykisk arbejdsmiljø og sygefravær. En to års opfølgning på PIFT undersøgelsen.

Denne ph.d. afhandling sammenfatter resultaterne af Projekt Intervention i Fravær og Trivsel (PIFT), som blev udført mens jeg var ansat på Arbejdsmiljøinstituttet (AMI)(fra oktober 2006: Nationalt Forskningscenter for Arbejdsmiljø, NFA).

Formålet med denne ph.d. var:

1. At etablere kohorten, udvikle et relevant spørgeskema, indsamle data og teste de psykometriske egenskaber af skalaer for psykiske arbejdsmiljøfaktorer, incl. 2 nye skalaer for mening i arbejdet og forudsigelighed i arbejdet (artikel 1).
2. At analysere effekten af psykosocialt arbejdsmiljø på sygefravær målt som antal fraværsdage (artikel 2), korte og lange fraværsperioder (artikel 4) og at beregne ætiologiske fraktioner som mål for den del af fraværet, der kan forebygges (artikel 3).
3. At sammenligne sammenhænge mellem psykosociale arbejdsmiljøfaktorer og fravær, når de psykosociale faktorer blev målt henholdsvis på individuelt niveau og som arbejdspladsgennemsnit (artikel 5).

Metoder: PIFT blev etableret i samarbejde med 3 organisationer, deres bedriftssundhedstjenester og forskergruppen. 52 arbejdspladser med 2730 ansatte ved baseline blev rekrutteret. Fraværsdata blev indhentet fra arbejdsgivernes løn- og personalekontorer, og til analyserne anvendtes data for perioden 24 måneder efter besvarelsen af baseline spørgeskemaet, der omfattede en lang række potentielle prædiktorer og confoundere. Cronbach's alpha blev anvendt til at teste skalaerne og Spearman korrelationer til de deskriptive analyser i artikel 1. Desuden anvendtes Poisson-regression i en model der tager højde for overspredning i data og begrænset opfølgningstid for en del af deltagerne i artikel 2 og 3, og multi-level Poisson-regression i artikel 5. Ætiologiske fraktioner i artikel 4 blev beregnet på grundlag af justerede rate ratioer.

Resultater: Sammenfattende ser det ud til at faktorer i arbejdsmiljø og sundhedsvaner, som kan forebygges, forklarer betydelige dele af fraværet fra arbejde. Seks af de syv anvendte psykosociale skalaer var statistisk sikkert knyttet til mindst et mål for fravær, inklusive de to nye skalaer for mening og forudsigelighed i arbejdet. Tilsammen forklarede de psykosociale arbejdsmiljøfaktorer 29 % af alle fraværsdage i den fuldt justerede model. Indflydelse i arbejdet var den mest betydningsfulde faktor, i overensstemmelse med tidligere forskning. Resultaterne for de øvrige skalaer varierede betydeligt med køn og med de forskellige mål for fravær. Justering for sundhedsvaner havde generelt beskeden indflydelse på sammenhængene med de psykosociale faktorer, mens fysiske arbejdsmiljøfaktorer havde større effekt på fraværet, og justering svækkede sammenhængene med psykosociale faktorer mere betydeligt. Justering for sense of coherence ændrede kun resultaterne ubetydeligt. Justering for social status til sammenligning, svækkede sammenhængene med psykosociale arbejdsmiljøfaktorer, men fjernede dem ikke.

Perspektiver: De bedst dokumenterede psykosociale risikofaktorer bør fremover indgå i indsatser til forebyggelse af unødvendigt fravær. Den dominerende tendens til ren observationel forskning på området bør ændres til interventionsforskning, der kan vurdere effekten af at reducere mistænkte risikofaktorer og styrke vidensgrundlaget for fremtidig forebyggelse.

Introduction

Background on work environment and absence

It is often implicitly supposed that there should be as little sickness absence as possible, preferably none. However, this is unrealistic, and would prohibit an inclusive labour market encompassing employees with health problems. But the proportion of absence caused by preventable causes could – and should – be diminished, and therefore we need to know more about the causes of absence and about effective prevention.

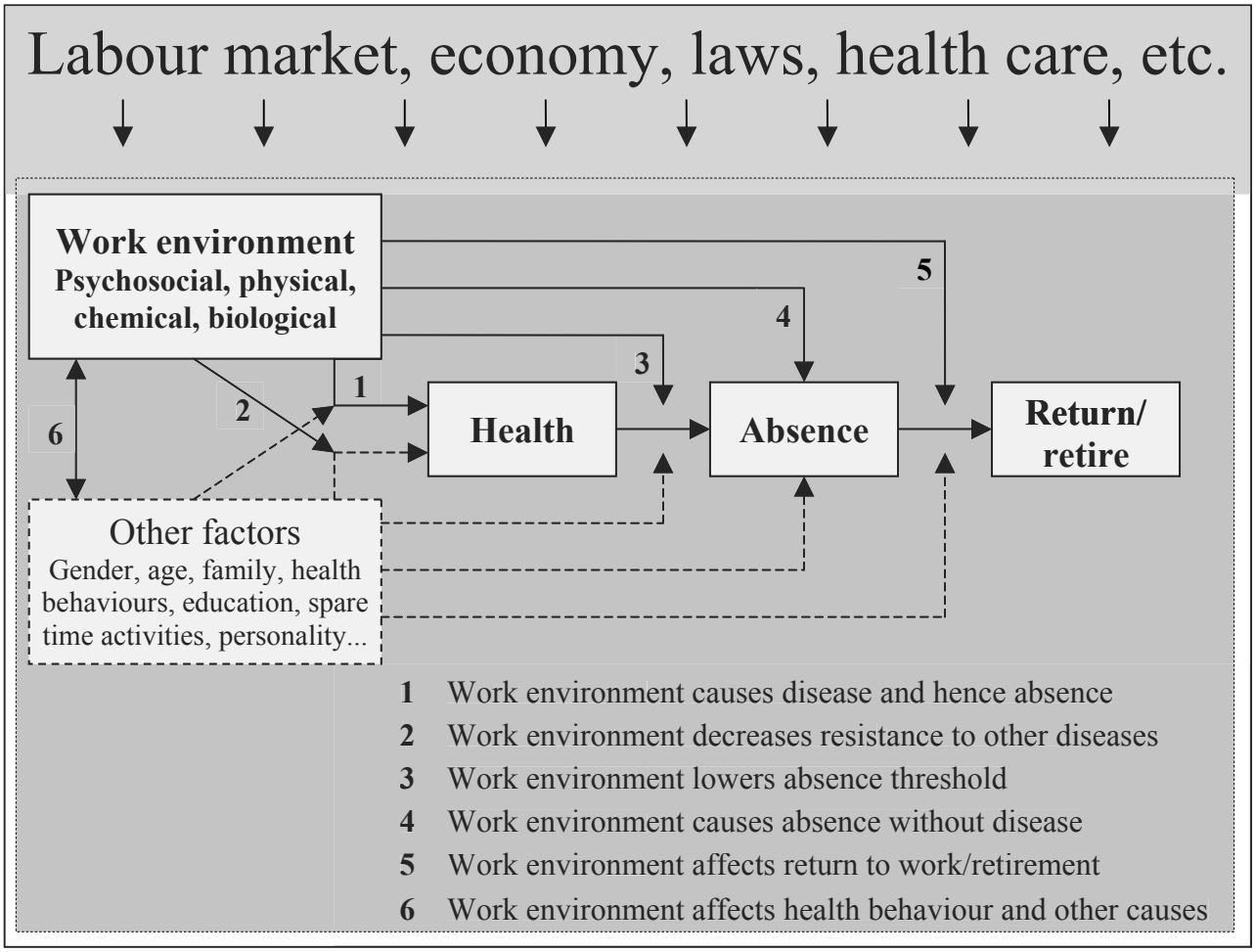
Absence from work is a problem for employee, employer and society. The employee is usually absent because of ill health, or sometimes other problems. Often absence is accompanied by reduced income as well as loss of social network, status, etc. Tasks are still to be done when the employee returns, or colleagues may have to work harder to catch up, which might induce a feeling of guilt in the absent worker. To the employer, absence represents delays, loss of quantity and quality in production, dissatisfied employees and customers, and other difficulties, usually including economic losses. For society, absence means loss of potential production and is often associated with costs for compensation, administration, and health care. However, loss of production may also appear when employees go to work in spite of illness, and are less productive than when healthy ("presenteeism" or "sickness presence"). But this is often less visible. This thesis will focus on the potential for reducing absence by improving the working environment.

A theoretical model
During the study, I gradually developed the model below (figure 1), to give an overview of the main pathways through which the work environment can impact sickness absence rates.

Research in occupational health has shown that numerous exposures at work can cause diseases and injuries that lead to absence (**Arrow 1** in figure 1). For example, it is now well known that exposure to asbestos increases the risks of asbestosis, mesothelioma and lung cancer, and that many years of heavy lifting increases the risk of disabling low back pain (Punnett et al. 2005). Based on such knowledge, lists of occupational diseases have been developed. In Denmark and many other countries, employees suffering from occupational injuries and diseases can claim compensation from authorities or insurances. During 2005, The National Board of Industrial Injuries in Denmark (Arbejdsskadestyrelsen) concluded 17570 claims about work accidents, of which 13023 were recognized, and 7272 of these were granted compensation. Also, 14510 claims about occupational diseases were concluded with 2652 cases acknowledged and 2265 of these compensated (Arbejdsskadestatistik 2005). By definition, the number of non-reported cases is not known, but studies indicate that underreporting is substantial (Haastrup 1993, Probst et al. 2008, Azaroff et al. 2002) and even so for fatal injuries (Wergeland et al. 2009).

Research findings also indicate that psychosocial working conditions and related psycho-physiological stress-reactions, might play an important role for the occurrence of several diseases and disorders that are not officially considered occupational diseases, including frequent and serious conditions like cardiovascular disease (Belkic et al. 2004, Netterstrøm and Kristensen 2005, Schnall et al. 2000) and depression (Stansfeld and Candy 2006, Netterstrøm et al. 2008, Bonde 2008). Based on Netterstrøm et al.'s review and a related Danish report, the National Board of Industrial Injuries has started to evaluate and compensate cases of depression after particularly stressful work periods characterised by high demands and low support.

Figure 1. Work environment and absence



Stressors in the psychosocial work environment and subsequent psycho-physiological stress-reactions may also affect the resistance to other causes of disease and absence (**Arrow 2**). Experimental research has shown that stress reduces the functioning of the immune system leading to an increased susceptibility to infections (Cohen 2005). Stress can also increase muscle tension and thus the risk of musculoskeletal complaints (Lundberg 1999, Lundberg 2002). Studies have further indicated that stress can affect sleep (Jansson and Linton 2006) and cause tiredness during work, and consequently an increased risk of accidents (Philip and Åkerstedt 2006).

In the case of an established health problem, the work environment will significantly affect the rate of absence (**Arrow 3**). It seems obvious that for example a construction worker with heavy manual handling tasks would face more difficulties performing his usual work with a condition of low back pain than a researcher or an occupational physician. In line with this, a Danish report has compared the sickness absence of the Danish working population during waiting time for hospital treatment for musculoskeletal diagnoses. Members of the unemployment insurances for different trades had very similar waiting times for diagnostics and treatment. However, the unskilled and semiskilled trades were much more often sick-listed for a larger proportion of the waiting time than academics (Asp and Petersen 2002). It can be argued that backaches among the un- and semiskilled workers were to some degree caused by their workload and that it was therefore advisable to put them on

sickleave. However, even autoimmune, inflammatory diseases like Reumatoid Arthritis that are not perceived as caused by work, result into different length of sickness absence in different occupational groups (Ødegård et al. 2005).

In some cases the work situation is unbearable for the employee, even without the presence of signs or symptoms that would make a physician able to diagnose a disease (**Arrow 4**). For example, an employee, who is subject to severe harassment or unjustified threats of being fired, but has not (yet) developed symptoms or objective signs that define a diagnosis, could find it necessary to stay away from work, regardless if laws or collective bargaining allow for compensation or not. The choice between presence and absence is influenced by more factors than health status itself. The decision to go to work or stay at home can be considered as part of a coping strategy (Kristensen 1991), affected by the perceived working environment and other factors.

In the situation when an employee is sick-listed for a long time and is not recovering completely, the work environment will also affect the possibility to return to work, and consequently the duration of the absence (**Arrow 5**). If the construction worker mentioned above was allowed to have less demanding tasks for a while, the worker could return to work earlier than if the heavy manual task was the only option. This is also discussed as "illness flexibility" (Johansson and Lundberg 2004). Associations between work conditions and time to return to work has been shown in several studies (Høgelund 2001, Lund et al. 2006b, Labriola et al. 2006b), and intervention studies have demonstrated that changes at the workplace that accommodate the needs of employees with reduced workability, can accelerate return to work (Loisel et al. 1997, Anema et al. 2004, Bültmann et al. 2009).

There are even more complex relations between work and absence. Stressful psychosocial work environment conditions tend to deteriorate the health behaviors of the employees, and this may lead to increasing morbidity and absence (**Arrow 6**). For example, it has been found that work related stress increase overweight and impede normalisation of underweight (Kouvonen et al. 2005a, Hannerz et al. 2004), increase smoking and make smoking cessation more difficult (Kouvonen et al. 2005b; Albertsen et al. 2003+2004, Rugulies et al. 2008), increase alcohol consumption (Kouvonen et al. 2005c, Head et al. 2004), and reduce physical exercise (Kouvonen et al. 2005d).

Sickness absence is also affected by many other factors than work, e.g. sociodemographic factors, health behaviors or personality factors as indicated in the lower left box in figure 1. Moreover, sickness absence rates in a given society is influenced by societal factors like political, economical, legal, and social conditions including unemployment rates and sickness absence benefits legislations, as well as access to, and quality of, health care. This is indicated at the top of the figure.

The model shown in figure 1 could be detailed further, e.g. by adding concepts like work ability, job satisfaction etc., or by considering more associations including reverse arrows. However, the point of the model is mainly to illustrate that when studying the statistical associations between work environment factors and absence, regardless of specific mechanisms, one will capture more than the limited number of generally recognized cases when the employee, the employer, and the doctor would agree that the absence is due to a disease caused by work.

Not all ill-health, work-related or not, leads to full-time absence from work. In some cases, workers shift to part-time work, and in many cases, workers tend to go to work although they are somewhat ill. In this case, recovery may be delayed, and productivity is likely to be reduced. This phenome-

non is sometime referred to as sickness presence or "presenteeism" (Aronsson and Gustafsson 2005) or lost productivity days (Schultz and Edington 2007).

Absence from work is strongly affected by health. However, it is not merely a simple reflection of a person's health or disease status but also a form of behaviour, which reflects health as well as broader life circumstances of the person – including the working conditions (Voss et al. 2001, Kivimäki et al. 1997, North et al. 1993, Kristensen 1991).

Empirical evidence

One of the most consistent findings on absence is a social gradient with more absence in lower socio-economic groups, regardless if status is measured by social class, job status, education, or income (Allebeck and Mastekaasa 2004). However, it is difficult to determine, to what extent sickness absence is caused by more adverse physical and psychosocial working conditions accompanying lower socioeconomic status, and to what extent it is caused by differences in non-work related factors such as upbringing, education, housing, diet, smoking, drinking, and leisure time activities (Allebeck and Mastekaasa 2004).

During the last few decades, a large number of studies have reported associations between psychosocial working environment factors and absence from work. However, in a comprehensive review on causes for absence regardless of diagnoses or disease, Allebeck and Mastekaasa found that only a limited number of studies on work factors were of adequate quality (Allebeck and Mastekaasa 2004).

Among the 20 reviewed studies on psychosocial factors, almost all studies used the demand – control – support model (Karasek and Theorell 1990, Johnson and Johansson 1991). High **job control** was almost unequivocally found to be associated with lower absence, whereas the findings were inconsistent for **demands** and **support**. In those studies that separated job control in its two components - **decision authority** and **skill discretion** - the former was a far more consistent predictor than the latter. The authors concluded that the evidence for an impact of psychosocial work environment factors on sickness absence is still limited and that more good research is needed.

The literature search for the review from Allebeck and Mastekaasa was completed in October 2002. Since then, no general reviews on work and sickness absence have been published, but 2 reviews and a meta-analysis have appeared that focus on specific aspects of sickness absence.

The first review focuses on clinical interventions in patients with chronic low back pain (Kuijer et al. 2006), and only few of the reviewed studies included other predictors than the intervention. One study (Schultz et al. 2004) indicated that psychosocial work factors were associated with absence outcomes, but only weakly so, and in the direction that high **skill discretion** at work and co-worker support reduced the likelihood of returning to work and increased the duration of disability.

A recent review of factors predicting return to work (RTW) for employees with poor mental health (Blank et al. 2008), summarise the following significant work-related factors: ''low job grade'', threat of unemployment, injury at work, no worker's insurance, and not attempting to RTW within 505 days. Furthermore, some factors that could be considered as psychosocial work environment, are mentioned: **supervisory behaviour**, including active and frequent communication with absent employees was found to be highly promoting for a faster return to work in employees without depression, but not with depression (Nieuwenhuijsen et al. 2004). And it was concluded that **high**

job stressors impede return to work (Semmer and Zapf 1996). Finally, **re-organisational stress** is mentioned as a negative factor, but unfortunately, I am unable to find a reference to the original study behind this factor.

A meta-analysis of studies on sickness absence due to psychosocial health complaints, published up to august 2006 (Duijts et al. 2007), confirmed the effect of low **job control** or **decision latitude**, partly based on the same studies as the Swedish review, partly on newer studies (Vahtera et al. 2004, Väänänen et al. 2004, Melchior et al. 2003).

Earlier findings on decision latitude, here called **influence at work**, were also supported by a more recent Swedish study (von Thiele et al. 2006) that tested the association of four different measures of registered sickness absence with psychosocial and physical work characteristics, in 1,726 employees at 48 dental clinics in Stockholm. The frequency of absence was associated with all the factors: physical work environment, physical load, **support**, **influence at work**, and worry. Considering duration between 2 and 21 days, there were significant differences in support, influence at work and physical work environment; for one-day absence, support, influence at work and physical load differed significantly. Conversely, there were no significant differences for the overall duration of absence.

A rare study, measuring exposures at 2 times, and absence rates at 2 follow-up times in 3,817 Whitehall civil servants (Head et al. 2006), found that change in work characteristics predicted subsequent incidence of long spells of sickness absence (>7 days) in the early follow up period. Adjusted rate ratios were 1.23 for decreased compared with stable **decision latitude**; 1.17 for increased compared with stable **job demands**, and 0.79 for increased compared with stable **work social support**. In the later follow up period, associations between work change and long spells of sickness absence were similar for decision latitude, less pronounced for job demands, and no longer apparent for social support. Changes in work characteristics were not associated with subsequent short spells of sickness absence (≤7 days).

An interesting study on the **control over worktime** was based of a subset of the large Finnish ten town study: 16,139 public sector employees who had no medically certified sickness absences (>3 days) in the preceding year (Ala-Mursula et al. 2005). In women, (but not convincingly in men) individually measured control over daily working hours and days off, moderated the association between **work stress** and sickness absence. The combination of high stress and good worktime control was associated with lower absence rates than a combination of high stress and poor worktime control. This finding was replicated in the analyses using workplace aggregates of worktime control instead of individual exposure.

A number of studies by Danish researchers, based on questionnaire exposure data from the Danish Work Environment Cohort Study and record linkage to payment of sick leave compensation by tax-financed social security (the DREAM register), showed that physical work environment explained the largest part of absence for more than 8 consecutive weeks, followed by health related behaviours and lastly the psychosocial work environment factors (the single studies are mentioned below).

One of these studies examined the effects of psychosocial risk factors on sickness absence for more than 8 consecutive weeks in 5,357 employees during 18 months (Lund et al. 2005), and found that in women, long-term sickness absence was associated with **role conflict**, low **reward**, and poor

management quality. In men, high **demands for hiding emotions** and high **emotional demands** predicted long-term sickness absence.

In a study focused on the physical work environment factors (Lund et al. 2006), risk of onset of long term sickness absence was increased by bending or twisting of the neck or the back, working mainly standing or squatting, lifting or carrying loads, and pushing or pulling loads. Significant interactions were found for three combinations of physical and psychosocial work environment risk factors among female employees.

Another study focused on the social gradient in absence (Christensen et al. 2008), and found that the gradient was reduced when controlling for physical work environment and health related behaviours. In lower skilled workers absence was 58-59% lower in men and 41-53% lower in women after this control. Further control for psychosocial work environment caused a limited further reduction in women, but no significant reduction in men.

In the same cohort, self-reported absence days in 2000 was found to be significantly associated with the following factors 5 years earlier: working with arms lifted/hands twisted, extreme bending/ stooping of the back/neck, repetitive monotonous work, low **skill discretion**, low **decision authority**, obesity, current and former smoking, poor self-rated health, female gender, increasing age and public employer. The etiological fraction attributable to differences in work environment exposures was 40% (Labriola et al. 2006).

The meta-analysis (Duijts et al. 2007) also added the factor "**fairness**" as a predictor, based on a Finnish study of 3,850 employees in a large private enterprise (Väänänen et al. 2004). The study focused on role clarity, fairness in the division of labour, and organizational climate, as predictors of the rates of recorded short (1-3 days), long (4-21 days), and very long (over 21 days) sickness absences. Analyses were stratified in white- and blue collar workers. In white-collar men, low **role clarity** was associated with a 3.0 times greater rate of very long absences. Low **fairness** in the division of labour predicted a 1.3-fold rate of long absences in blue-collar men. In blue-collar women, poor **organizational climate** was associated with a 1.6 times greater rate of short absence spells, but among white-collar women all associations were weak.

Fairness, or **justice**, was also found predictive in the Finnish ten town study (Elovainio et al. 2005) that examined whether the combination of **uncertainty** (lack of work-time control, and negative changes at work) and **organizational justice** (i.e., justice of decision-making procedures and interpersonal treatment at work) contributes to sickness absence. 7,083 male and 24,317 female Finnish public sector employees participated. After adjustment for age, income, and health behaviours, low **procedural and interactional justice** were related to long sickness absence spells. In accordance with the uncertainty management model, these associations were dependent on experienced work-time control and perceived changes at work.

Studies of **effort-reward imbalance** and absence are scarce, and results are not very clear, although the effort-reward model (Siegrist 1996) is widely acknowledged, and often used together with the demand-control-support model. The model states that imbalance between efforts and reward has the potential to cause negative health effects. Efforts can be extrinsic, similar to work demands in the demand-control-support model, or intrinsic, i.e. originating within the worker. The term over-commitment describes a state where the worker has a propensity to do more than others expect, to

fulfil the work-role, and thus have a larger need for reward to perceive balance. Rewards can be not only the pay-check, but also feed-back, status, promotion etc.
In their general review on effort-reward, including many other outcomes than absence, Tsutsumi and Kawakami (2004) states that inconsistent results may be due to methodological flaws. They argue that a follow-up of one year, which is used in many studies, is too short, as overcommitted employees are less likely to take absence within this time, even when stress indices were elevated. This represents a situation with large demands of presence that forbid the employee to be absent, or behavioural patterns showing inability to withdraw from work. They argue that health effects causing absence may arise in a little longer perspective, whereas psychosomatic symptoms are better to monitor effects of effort-reward imbalance in a shorter perspective.
On the other hand, it could be argued that neither stressful work conditions nor over-commitment arise suddenly at the beginning of a study, but has more likely been present for a while before baseline, so effects could be expected even with shorter follow-up times.

A more recent study on day-to-day absence data of 1,524 employees at a German manufacturing plant (Hanebuth et al. 2006) found that **effort-reward imbalance**, lack of **support by supervisors or coworkers**, negative affectivity, exhaustion, and impaired health perception were significantly associated with absence spells and the time lost index. **Job demands** and **job control** as well as **overcommitment** were unrelated to absenteeism indices. Multivariate models suggest mediation through impaired health-related quality of life.

An article from the ten town study report on the effect of **downsizing** on sickness absence and mortality during 7.5 years of follow-up (Vahtera et al. 2004). Major downsizing (> 18% reduction of personnel) was associated with an increase in sickness absence in permanent employees but not in temporary employees. The extent of downsizing was also associated with cardiovascular deaths.

A Swedish study (Westerlund et al. 2004), found that not only **downsizing**, but also large **expansions** (18 % or more per year) was associated with an increase in very long sick leaves (90 days or longer) and increase in hospital admissions for specific diagnoses.

In data from the Maastricht Cohort Study (Jansen et al. 2006), six months of follow up on 5,072 men and 1,015 women showed that **work-family conflict**, **work-home interference**, and **home-work interference** were all associated with a higher odds of being absent.

A recent Danish study found that a single question on **satisfaction with the psychosocial work environment** was a better predictor than multiple scales on different aspects of the psychosocial work environment, and that these scales did not further predict absence, when the single question was included in the analyses (Munch-Hansen et al. 2008).

In summary, during the last decades, the evidence for a causal influence of the psychosocial work environment on sickness absence has been growing. As confirmed by the meta-analysis (Duijts et al. 2007), it seems convincing for job control or decision authority, whereas many other factors are inconclusive because of mixed results (job demands, social support, skill discretion, effort-reward imbalance), or because they have only been tested in one or very few studies (supervisory behaviour, control over work-time, role conflict, role clarity, management quality, emotional demands, demands for hiding emotions, fairness, organizational justice, procedural and interactional justice, organizational climate, downsizing, expansions, work-family conflict, work-home interference, home-work interference, satisfaction with the psychosocial work environment). The

comprehensive Swedish review (Allebeck and Mastekaasa 2004) concluded that the associations between psychosocial workplace factors and sickness absence had been under-researched so far. This is less true today, but we still face the challenge how to explain the conflicting results for some factors, and to study new factors that are claimed to explain parts of the sickness absence. And we need to perform intervention and implementation research to test the preventive effects of the findings from observational studies and strengthen the knowledge base for prevention.

Background on IPAW

Initiation by organisations and occupational health services
The initiative to launch an intervention study on absence and well-being originally came from three occupational health services (OHS's) in the Copenhagen area. Each of the three OHS's had been approached by workplaces within their organisation where absence was perceived to be "too high". In general, physical work environment problems had been addressed for years, and management had tried to solve the absence problem through individual level interventions (such as meetings with individual employees with "too many" absence days). These initiatives had not had the desired effect, and the employers had then agreed with representatives of the workers that there was a problem with the "psychosocial work environment". Both parties at the workplaces hoped that the OHS's could come up with a solution to the problem. At the National Institute of Occupational Health (NIOH) we found it very interesting that the three different OHS's had been approached by different workplaces with the same problem, and an interest in preventive action.

Thus, the initiative was supported by employers as well as employees - but for different reasons: the employers wanted lower absence rates while the employees hoped for better psychosocial working conditions and well-being.

The OHS's were associated with different organisations: a large pharmaceutical company (production factories, packaging units, laboratories, canteens and cleaning departments), the municipal technical services of Copenhagen (cemeteries, parks, workshops, sewage pumping stations, road construction and repair, administrative offices) and municipal care in Copenhagen (15 nursing homes for the elderly and 7 institutions for mentally handicapped). Workplaces in the 3 organisations became the units of intervention and comparison.

After some meetings, first with occupational physicians from the three organisations, and later with representatives from the work-sites, it was decided to start a common project – the Intervention Project on Absence and Well-being, IPAW. In each of the three organisations, project committees representing employees, first-line supervisors, top management, human resources departments, OHS, consultants, and the research group were formed to supervise and support the project and to help disseminate the experiences to other workplaces in the respective organisation.

The organisations accepted to include control workplaces, but they were not willing to accept a randomized design, because this was viewed as unrealistic. Intervention workplaces needed to be enthusiastic, and this could not be randomised. As the number of workplaces was not large enough to effectively control for selection bias and unmeasured confounding, we did not insist on randomisation. It was considered necessary for the workplaces to have support from consultants, and the organisations agreed to pay for that. It is important to note that for participating workplaces in each of the three organisations, the project included only their respective part of the study. They did not even use the name IPAW, and they have never actually met each other across organisations.

For us as researchers, it was important that the participating work-sites had a ”feeling of ownership” in relation to the project (Israel et al. 1992), since this would be an important aspect of the necessary commitment to the whole intervention process.

In practice it turned out that although the work-sites had chosen to participate, many workers and quite a few middle managers had, in fact, not been involved in the decision process and had sometimes not even been informed. This obviously affected the motivation for active participation in the project, and partly the effort needed to establish trust in the purpose of the project and the confidentiality of questionnaire and absence data. We did meet scepticism and expectations that employers would use the project to get rid of the most absent workers, or use decreases in absence to reduce the workforce. Some workplaces made written agreements against this.

Societal context: The Danish social system

In Denmark, the wage loss during sick leave is partly compensated for all employees (sygedag-penge). The system is based on a “no fault”-principle: Sick-leave is compensated regardless if it is caused by factors in the work. The first two weeks are paid by the employer (from 2008 three weeks) and after this, the employer is compensated by the tax-paid social security administered by the municipalities. The compensation is a fixed amount that is lower than the normal wage for unskilled work. Employees with higher educations and wages often have collective bargains securing full compensation, with the difference paid by the employer.

The absent employee must present a certificate from a physician if the employer requests it, which is not always the case. After at least three days of absence, the visit to the general practitioner for this purpose is paid by the tax-financed health insurance. If the certificate is requested earlier, the employer must pay the doctors fee. The certificate is not allowed to inform the employer about diagnoses, but should state if sickness absence is expected to be of shorter or longer duration. The municipal social security office is obliged to contact all employees sick-listed for more than eight weeks and make a plan to facilitate return to work. Certificates to case-managers will include diagnoses and other medical information. During recent years, there have been numerous initiatives and negotiations to increase the efforts by employer, employee, physician and case-manager to prevent disability and facilitate use of the employee’s work ability, even if limited.

If the employee is not back in work after a year, the compensation ends. If the former worker does not qualify for disability pension (førtidspension), she may or may not receive a lower income replacement (kontanthjælp), depending on the total household income. If there is an ongoing case of disability pension or workers compensation, or a statement from a physician, that the employer is about to retrieve work ability, the one-year compensation may be prolonged.

There is no legal protection against firing of employees on sick leave, and the employer’s economical obligations ends when the contract ends. This is often given the notion of “flexicurity” – **flexi**bility due to the ease of firing, and se**curity** due to the general compensation.

During the study period (1996-2001), the unemployment rate was relatively low, and the average absence rate was around 5 percent (Exact, general absence statistics does not exist).

More historical details and a further discussion of the Danish sickness absence legislation are given in (Johansen et al. 2008).

Basic details on local compensation systems should be included in study descriptions, since differences in regulations and compensations systems may partly explain differences between findings in studies performed in different societies.

Aims of IPAW and of this PhD thesis
The main aims of IPAW were

A. To analyze the impact of psychosocial work environment factors on sickness absence in a prospective study that uses absence data from employers' registries and that includes a wide range of covariates.
B. To analyze the impact of the psychosocial work environment on employees' health and well-being.
C. To evaluate the feasibility of workplace interventions, including the identification of factors facilitating and inhibiting the implementation of workplace interventions.
D. To analyze if the intervention workplaces showed a more favourable development in absence rates and employees' health and well-being compared to the control workplaces.

This PhD thesis is about the first aim, the prospective analyses on the impact of the psychosocial work environment on sickness absence. The specific study aims for this PhD are:

1. To establish the cohort, collect data, and test the psychometric properties of the psychosocial work environment variables, including two newly designed variables on meaning of work and predictability of work (article 1)
2. To analyze the impact of the psychosocial work environment variables on numbers of sickness absence days in a two-year follow-up, adjusted for a wide range of confounders, including physical work environment factors (article 2)
3. To calculate the etiologic fraction, i.e. the amount of sickness absence that could be prevented, if absence rates were at the level of the workplaces with best psychosocial work environment conditions (article 3)
4. To calculate if psychosocial work environment factors have a different impact on short and long spells of sickness absence (article 4)
5. To analyze similarities and differences in associations between psychosocial work environment factors and sickness absence when the psychosocial work environment is measured on the individual level and the workplace level respectively (article 5).

Methods

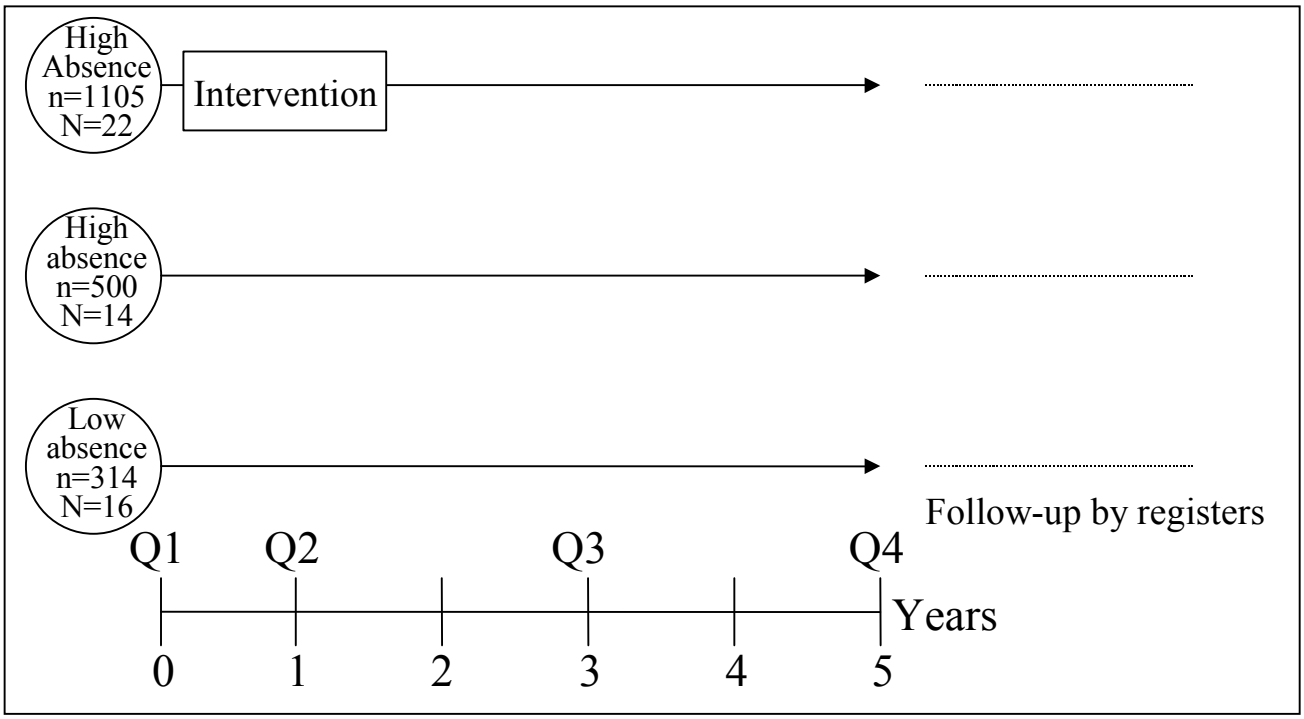
Study design

The analyses in this PhD are based on data from the IPAW study. However, as stated above, this PhD does not include analyses on the interventions. Here, the IPAW data are used to analyze if psychosocial work environment factors measured at baseline influence company-registered sickness absence for the following 2 years.

The basic design of IPAW is shown in figure 2. Three categories of work-sites were included: high-absence intervention work-sites, high-absence control work-sites, and low absence control work-sites. We included low-absence control work-sites for a number of reasons. First, we wanted to be able to study the variation in psychosocial factors between high- and low-absence work-sites at baseline and during follow-up. Second, we thought it important to be able to study possible regression to the mean among high- as well as low-absence work-sites. Third, we thought that it would be interesting to study the low absence work-sites prospectively in order to see if they could keep the absence rates low during a longer period.

Data were collected via questionnaires at baseline (Q1), and after approximately 1 year (11-18 months), 3 years (34-41 months) and 5 years (59-66 months) (Q2, Q3 and Q4). During summer 2002, the final 5-year follow-up questionnaire survey was ended and absence data including 2001 collected. For this PhD, data from the baseline survey (Q1) and company-registered data on sickness absence for the 2 years after the baseline survey were used.

Figure 2. The design of the Intervention Project on Absence and Well-being (IPAW).



N = number of workplaces, n = number of analysed respondents, Q1 – 4 = questionnaires 1- 4.

The dotted lines in figure 2 represent the possibility to follow the participants in various registers (such as the national death and hospitalisation registers, registers of transfer income in case of long-term sickness absence, unemployment, pension etc.) via Personal Registration Numbers issued to all Danes by the authorities, and used for identification in registers.

Model for workplace interventions

Although analyses of the workplace interventions conducted in IPAW are not part of this PhD thesis, a brief description of the theoretical model underlying these interventions should be given here.

The theoretical model of the IPAW intervention is shown in figure 3. A systematic psychosocial intervention at the organizational and interpersonal level was planned to take place at the intervention work-sites. The aim of the interventions was to improve the psychosocial work environment by focusing on five basic dimensions of work stressors.

According to our basic model, improvement of the psychosocial work environment is assumed to improve job satisfaction, health, and psychological well-being. Health and psychological well-being were measured with seven scales as shown in the figure. Finally, absence from work and labour

turnover were expected to decrease as a result of improved working conditions, higher job satisfaction, and improved health and psychological well-being.

In our communication with the project committees, the goals of the interventions were defined as in figure 3: high control, high support, high meaning, high predictability, and *suitable* demands. This combination of key psychosocial factors at work comes very close to the concept ”developmental work” (”udviklende arbejde”), which combines development of individual, work, and organization and is a well-known concept in the Danish labour market (Hvid and Hasle 2003).

The three steps of the interventions
As mentioned, the intervention effects are not analysed here, but as they could be seen as potential confounders of results in the observational, longitudinal data, a brief description will be given.
In general, all workplace interventions were conducted in three steps:

1) Survey of the psychosocial work environment
After the baseline questionnaire (Q1 in figure 2), each workplace received a report with detailed scores on the psychosocial workplace factors. In addition, workplace interviews by external consultants were conducted and the local Health and Safety committees summarized existing "agendas."

2) Prioritising of problems and solutions
A working group presented results of the survey at a seminar for all the employees at the workplace. At this presentation, it was discussed what problems were most important, and proposals for solutions were collected. The working group prepared more detailed action plans and presented them at a new seminar, where priorities were decided.

3) Implementation of the selected actions
One or more working groups worked for one to two years to implement different changes, e.g. organisational changes, delegation of responsibilities, improving information and communication, mutual support, better prioritising and planning of work tasks etc. The associated consultants supported the work groups and to some extent contributed with education and supervision of local supervisors.

During follow-up, the workplaces had feed-back reports on changes in work environment, based on subsequent questionnaires (Q2-Q4).

Worksites and respondents
IPAW includes 52 Danish worksites with 2,730 employees at baseline (excluding temporary contracts). Of these, 22 served as intervention workplaces, 14 as high absence control workplaces and 16 as low absence control workplaces (figure 2).

The baseline questionnaire was sent to the participants between May 1996 and April 1997. Of the 2,730 employees, 2,053 completed the questionnaire, yielding a participation rate of 75.2%. We had information from absence registers for 1980 of the respondents (96%). Only 53 respondents were 60 years or older, reflecting the common use of early retirement in Denmark. We consequently excluded these highly selected subjects. We further excluded eight trainees and apprentices, yielding a final sample for the follow-up analyses on sickness absence of 1,919 individuals (corresponding to 93% of all respondents and 70% of all employees). The mean age of these

respondents was 40 years, and 68% were women. The level of education and social status was generally low, 63% were unskilled, semi-skilled or skilled workers.

The worksites belong to 3 organizations in the Copenhagen area: 1) a major pharmaceutical company (production factories, packaging units, laboratories, canteens and cleaning departments; 13 workplaces, 676 respondents), 2) municipal workplaces in the care sector (15 nursing homes for the elderly and 7 institutions for mentally handicapped; 927 respondents), and 3) the technical services of the municipality (cemeteries, parks, workshops, sewage pumping stations, road construction and repair, administrative offices; 17 workplaces, 316 respondents).

In article 1, fifteen participants who had answered less than 25% of the items in the questionnaire, were still counted as respondents, but as they proved useless for analyses due to lacking answers on most items, they were excluded in the rest of the articles. For this reason, the numbers given here are slightly different from those in article 1, where 2,068 were counted as respondents and the response rate calculated to be 76%.

Data collection

The analyses of this PhD are based on two data sources:

1) The baseline survey questionnaires, which measured psychosocial working conditions and important covariates, including physical working conditions, socioeconomic status, health related behaviours, self-rated health, family characteristics, and personality.
2) 2) Sickness absence registries from the 3 organisations to assess number of days and spells of sickness absence of the study participants.

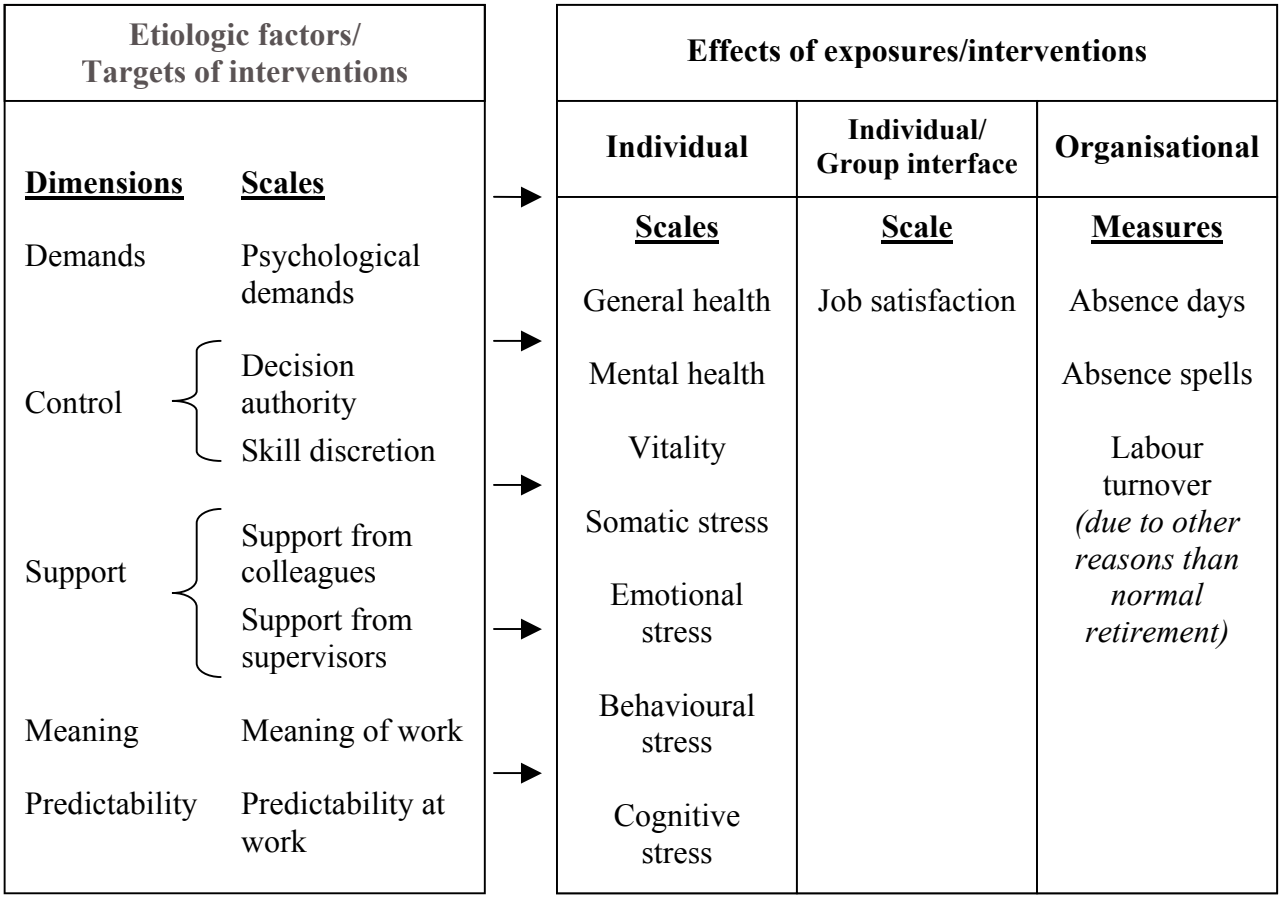
Psychosocial work environment scales
Based on general stress theory (Frankenhaeuser 1991, Johnson and Johansson 1991, Karasek and Theorell 1990, Levi 1984, Sapolsky 1994) we decided to add two new dimensions to the demand-control-support model and focus on the five dimensions: psychological demands, control, social support, meaning of work, and predictability of work. In IPAW, these dimensions were measured with seven questionnaire-based scales as indicated in figure 3. Control was divided into the two measures decision authority and skill discretion. Likewise, support was measured as support from colleagues and supervisors, respectively.

The measures of the two dimensions ”meaning of work” and ”predictability” were developed by us. Meaning of work is present if the respondent finds the work tasks meaningful and feels that the work is important and useful for others. Predictability refers to relevant and useful information about major future events at the work-site, such as changes in the organization of work, new technology, physical changes, etc. The two scales have four items on meaning and two on predictability (listed in article 2), each item with five response categories ranging from “fits precisely” to “doesn’t fit”. The two scales were subsequently included in the development of the Copenhagen Psychosocial Questionnaire (COPSOQ) (Kristensen et al. 2005) covering a wide range of psychosocial work environment factors, and later translated into several languages.

The questions for the scales on psychological demands, decision authority, and skill discretion, were derived from the Whitehall II study (Marmot et al. 1991) and translated into Danish in a previous study that also developed the questions on support from colleagues and supervisor

(Netterstrøm et al. 1998). These five scales consist of two to eight items, each with four response categories ranging from "often" to "never".

Figure 3. The basic analytical model of IPAW



All seven scales were coded according to their names, i.e. high scores are unfavorable for psychological demands and favorable for the other variables.

Covariates

Exposures in the *physical work environment* were measured by single questions on how much of the daily working time one is exposed to the following: twisting the back, stooping work position, lifting more than 30 kg, pushing/pulling heavy burdens, repeating the same job task many times per hour, loud noise, temperature fluctuations, cold, and dust. For each exposure, we asked the respondents how often they occurred, with six response categories ranging from "almost all the time" to "never". We further asked respondents to rate the intensity of physical activity at work on a five-point scale ranging from "very light" to "very heavy".

Socioeconomic status was defined based on questions about employment grade, education and job-title. For 1,796 of the 1,919 people we had sufficient data to code SES. The respondents were classified into six groups (managers/academics, middle managers, other white-collar, skilled blue collar workers, semi-skilled and unskilled workers).

Health related behaviours were covered by questions on smoking, alcohol consumption, and height (in cm) and weight (in kg) from which we calculated body mass index (BMI). Regarding smoking, we asked the participants if they smoked daily, with the response categories: (1) Yes, (2) No, but I have been smoking, and (3) No, I have never been smoking. Currents smokers were further asked to state how many cigarettes, cheroots, cigars, or how many grams of pipe tobacco they smoked on a regular day and based on this information we calculated consumption of tobacco per day. With regard to alcohol consumption we asked the respondents to state the average numbers of drinks per week during the last year. Respondents had the option to express this in number of (1) bottles of beer (33 cl), (2) glasses of wine, or (3) 2 cl-amounts of strong liquor and based on this information we calculated number of units of alcohol per week.

The *family type* variable is based on questions on cohabitation, total number of children in the home, and the number of children below 7 years. It was coded into one of the following values: 1 = single without children, 2 = couple without children, 3 = couple with children that are all seven years or older, 4 = couple with children below seven years (including those with older siblings), 5 = single parent. Family type is included in analyses as a categorical variable.

Sense of coherence was measured by a Danish translation of a Swedish nine-item scale (Setterlind and Larsson 1995) developed on the basis of Antonovsky's work. Due to the psychometric properties, the original 3 subscales were merged in one scale with a Cronbach's alpha of 0.77 (Albertsen et al. 2001).

Three scales from the Danish version of the Short Form 36 (SF-36) questionnaire (Ware et al.1993, Bjorner et al. 1998) were used to assess *general health*, *mental health* and *vitality*.

Measurement of sickness absence
From personnel offices in the 3 organisations, we received absence data for every participating individual for the period 1.1.1995 to 31.12.2001 (unless the duration of employment was shorter). For the analysis in this PhD we used absence data recorded during the 24 months after the individual's completion of the baseline questionnaire. In article 1, self-reported absence data from questionnaires are used.

For each spell of absence we received the first and last day and a code for the type of absence. We calculated absence due to the employees' own sickness, including work injuries and occupational diseases and excluded absence due to other reasons, such as a child's first sick-day or pregnancy-related absence, vacation or maternity leave. We collapsed consecutive or overlapping periods. When calculating the length of the spells, we divided by 7 and multiplied by 5 when the spell was longer than a week, to adjust for weekends. Some of the employees also work nights and weekends. As we did not have access to the specific individual working schedules, we were not able to make this correction more precise. Via the personal identification number, absence data was linked with questionnaire answers.

Data analyses

Questionnaire data were entered twice by a professional bureau. The two files were compared and any inconsistencies checked with the questionnaire. The answers were screened for unrealistic or contradicting values and double-checked. We also compared age, gender and workplace with the registered Personal ID. These procedures made it possible to correct entering errors and other

mishaps, as for instance two respondents living on same address that had incidentally switched questionnaires.

We calculated the scores on psychosocial work environment scales by adding the scores of all included items and then transforming the sum to a score ranging from 0 to 100 for each scale. If there were missing answers to single questions, we used the convention of the SF-36 questionnaire (Ware et al. 1993). According to this convention, a score on a scale is calculated for a person if the person has answered at least half of the questions of the scale. Otherwise the value is missing.

The descriptive analyses in article 1 were made by calculation of the Cronbach's alpha for each scale and Spearman correlations between the scales and with self-reported absence days and spells. In article 2-5 the outcome variables were based on absence registered by the employer. In article 4, it was the number of short or long absence spells, in the rest of the articles it was the number of absence days.

Etiologic analyses in article 2-4 were generally performed separately by gender, and were adjusted by the following confounders: age, physical work environment factors, health related behaviours (smoking, alcohol consumption, body mass index), family type (single/couple, young or older children). The analyses were also adjusted for organisation and a variable called "intervention assignment", which indicates if a study participant worked at an intervention workplace, a high absence control workplace or a low absence control workplace. And in some cases further adjusted for socio-economic status (SES) and personality (Sense of Coherence, SOC).

As absence days are counting data and do not follow the normal distribution, the Poisson distribution is more feasible. In articles 2, 3, and 4, multiple Poisson regression was employed in the SAS package, using the GENMOD procedure. As in previous studies (North et al. 1993, Niedhammer et al. 1998), a scale parameter was used to specify an over-dispersed model. This means that standard errors (s.e.) are adjusted according to the over-dispersion. Furthermore, the covariates were standardized to a mean of zero and a variance of one. The regression parameters can then be interpreted as the relative change in number of absence days (i.e. the rate ratio, RR) when moving one standard deviation on the dimension of the independent variable.

For 300 participants with less than 2 years of follow-up, the logarithm of the actual observation time was included as an off-set variable, that is, a regression variable with a constant coefficient of one for each observation (McCullagh and Nelder 1989).

In article 4, we divided each of the seven psychosocial scales into quartiles and calculated crude and adjusted rate ratios (RRs). Based on RRs, we calculated the EF of the psychosocial work environment scales. When calculating EF, we used the quartile with the most favorable psychosocial exposure as the reference group (low score for demands, high score for other variables). Based on the actual distributions of the scores, the size of the reference group for different variables could not always be exactly 25%, but varies from 20.3% to 36.2%. The EF expresses the excess of absence in the three most unfavorable quartiles of exposure, or, in other words, how many percent of absence days that would not have occurred, if exposure for all employees had been at the level of the most favorable quartile (Miettinen 1974, Olsen and Kristensen 1991). After the calculation of the EF for each factor, we calculated the overall EF for the seven psychosocial factors by the sum-formula given by Miettinen (1974). The use of the sum-formula rests on two theoretical conditions: that there are no interactions between the effects of predictors on the outcome, and that predictors are

not statistically correlated. We found the predictors not to have significant interactions and to have low correlations. Sensitivity analyses showed that the results were robust beyond the actual range of correlations.

In article 5, the analyses were based on workplace means of predictors instead of individual scores. Analyses were stratified by the three organizations. We determined how much of the variance in each of the seven psychosocial factors was explained by differences between workplaces. These analyses were conducted by calculating multiple correlation coefficients (R^2). If 10% or more of the variance of a psychosocial factor was explained by workplace differences in any strata, the factor was retained for the next steps in the analyses.
In the second step, we plotted workplace-level psychosocial factors against the logarithm of workplace level absence rates. We calculated regression coefficients for the different workplaces weighted by the number of subjects at each workplace and added the trend line to the plots.
In the third step, we used a multi-level Poisson regression model to model the number y_{ij} of sickness absence days for individual i in workplace j. The effect of individual level covariates X_{ij1}, X_{ij2}, . . . , X_{ijl} (e.g., gender and age) and of workplace level covariates Z_{j1}, Z_{j2}, . . . , Z_{jp} (eg, mean level of influence at workplace j) are studied, and a random workplace effect ε_j, assumed to be normally distributed is added. This model takes the clustered structure of the data into account and quantifies the between workplace variation, because the variance of the random workplace effect is estimated. The multilevel Poisson regression model was fitted using the GLIMMIX macro.

Results

Participation, response rates and attrition

At baseline, the 52 workplaces had 2,730 employees. The questionnaire was completed by 2,053, yielding a participation rate of 75.2%. We had information from absence registers for 1,980 of the respondents (96%).

Table 1. Respondents with absence data before baseline, who left the job (dropouts) or stayed in the cohort during follow-up. Numbers, mean absences and odds ratios for leaving, given high absence.

Workplaces	Dropouts		"Stayers"		Odds	
	No.	Mean absences	No.	Mean absences	Ratio	95% CI
Pharmaceutical comp.						
Intervention	26	5.9	330	6.6	1.023	0.951-1.101
Control high absence	19	6.8	202	5.2	0.936	0.843-1.040
Control low absence	3	4.2	63	2.7	0.836	0.526-1.328
Municipal care						
Intervention	208	2.5	220	2.8	1.060	0.972-1.157
Control high absence	40	2.3	72	2.2	0.980	0.788-1.218
Control low absence	42	2.2	105	2.7	1.105	0.948-1.288
Mun. Techn. Services						
Intervention	22	0.8	8	2.6	1.992	1.004-3.951
Control high absence	88	0.0	72	1.8	5.523	2.109-14.47
Control low absence	63	0	43	1.7	n.a.	n.a.

n.a.: Not available. Can not be calculated, as the denominator is 0.

Analyses of drop-outs showed that the number of absence spells in the 2 years before the project (for those employed at that time) did only increase the risk for later termination of employment in one of the three organisations, and only in the control workplaces (Table 1). This was the case in the smallest organisation, the municipal technical services, where both absence and drop-out rates were highest. As can be seen in the table, we are dealing with small numbers and therefore wide confidence intervals in this subgroup.

Summary of the five articles

The five papers included in this thesis are based on the data and methods described above. The following paragraphs present a summary of the results from each paper.

Article 1: The Intervention Project on Absence and Well-being (IPAW): Design and results from the baseline of a 5-year study
This paper presents the background, design, and baseline questionnaire data of the project.

In co-operation with occupational health services and central safety committees in three major organisations in the Copenhagen area, we designed a controlled intervention study with five years follow up, and recruited 52 workplaces in public and private service and production. We collaborated with the organisations to assign workplaces to intervention or control status, and to establish working groups and consultant assistance for the intervention workplaces. The organisations did not find randomization feasible. Staff functions within the organisations provided registered absence data for participating employees, but were unable to provide productivity data that we had wished to include.

The intervention workplaces were matched with two sets of comparable control workplaces, with relatively high versus low absence rates during the two previous years. We intended to include two controls for each intervention workplace, but as explained in article 1, we ended up with 22 intervention workplaces, 14 controls with high absence and 16 control workplaces with low absence rates.

Self-reported annual rates of absence days and spells at baseline were generally lower at the "low absence control" workplaces, but differences were modest (0.6-3.9 days, 0.3-0.5 spells) and in the technical services, the number of absence spells was almost identical.

We developed a questionnaire including psychosocial variables from the demand – control – support model, supplemented with new items on predictability and meaning of work based on general stress theory. We further included a wide range of items on physical work environment, health related behaviours, socio-demographic information, self-rated health, well-being, satisfaction, stress-symptoms etc. The use of Personal Registration Numbers made it possible to make precise linking between questionnaire data and registered absence, and provided the opportunity to follow up the participants in later record linkage studies.

The level of missing answers to the questionnaire items in each scale was 1.6% or lower, except for one scale with 4.2% missing data. The psychosocial scales range from 0 to 100 and had mean scores of 50.8 to 76.7. The scales generally had a good internal reliability, although the two-item scale on psychological demands had a Cronbach's alpha of only 0.56. Inter-item correlations within scales were in the range 0.18-0.76. Inter-correlations between the seven scales were moderate (in

the range 0.04-0.44), supporting the assumption that they do measure separate dimensions. Decision authority and skill discretion that have often been collapsed in the measure decision latitude or job control, had an inter-correlation of only 0.35 and quite different correlations with the other factors, and are used separately in this study. The eight different health measures were more strongly correlated, ranging from 0.10 to 0.75.

Correlations between work environment factors and health indicators ranged up to 0.22 and most of them were significant. The exceptions were psychological demands and support from colleagues that were not significantly associated with self-reported absence days or absence spells, and skill discretion that was not significantly associated with mental health or the four stress symptom measures. The correlations found were not interpreted as causal, as they were cross-sectional and not adjusted for potential confounders. However, they provide a good background for deciding to go on with causal analyses of the data.

In summary, we successfully organised the settings for the study, developed a comprehensive questionnaire including two new scales on predictability and meaning, and collected baseline data. We found response rates, scale properties, and correlations between scales acceptable, and data promising for follow-up analyses.

Article 2: Impact of the psychosocial work environment on registered sickness absence from work: A two-year longitudinal study using the IPAW cohort
In this article, we present associations between baseline scores on the seven psychosocial work environment scales and the number of registered absence days during the next 24 months.

The mean number of absence days per year was 12.7 for women and 11.8 for men. In the fully adjusted model, high levels of decision authority significantly predicted low levels of absence days in both men (OR: 0.84, CI: 0.72-0.86) and women (OR: 0.81; CI: 0.72-0.92), and a high score on the scale for predictability was associated with lower absence in men (OR: 0.82, CI: 0.70-0.95). When removing non-significant psychosocial variables from the model, the estimate for skill discretion became significantly positive in women, that is, high skill discretion predicted higher absence (OR: 1.08, CI: 1.01-1.16), in contrast with expectations.

Adjusting the analyses for SES is controversial, since the analysed factors are unequally distributed between social strata, and over-adjustment may cause an underestimation of true associations. When we adjusted for SES for comparison, only small changes occurred. In women, SES was a significant predictor in the model, and estimates for decision authority and skill discretion were slightly weakened, but in men, the estimate for decision authority was strengthened, and SES was not significant. Repeating analyses including Sense of coherence or restricting data to participants from control workplaces elicited no important changes.

In summary, high decision authority was a significant predictor of fewer absence days in both genders, whereas predictability was so only in men. This was true even after adjustment for physical work environment factors that attenuated the associations somewhat. The findings were robust for adjustments by SES, SOC, or leaving out intervention workplaces from the analyses.

Article 3: Psychosocial work environment and registered absence from work. Estimating the etiologic fraction

This article is intended to estimate, how much of the absence that is explained by psychosocial working environment.

When comparing four quartiles of exposure for each of the seven psychosocial variables, adjusted for age, gender, family status, organization and intervention assignment, 5 of the 7 factors had a significant trend of increasing absence with exposure. Only colleague support and meaning of work did not.

Histograms illustrated different patterns. Decision authority and psychological demands showed almost linear increases, whereas predictability and meaning had elevated rate ratios (RR) only in the most unfavourable fourth quartile. Skill discretion and supervisor support had raised RR's already in the second quartile and no substantial further increase in the third and fourth quartile. Finally, colleague support had a more J-shaped association with the second quartile having the lowest RR and only the fourth quartile being slightly above 1.

When adjusting for the health related behaviours smoking, alcohol consumption and body mass index (BMI), estimates changed very little, and the total EF in Model II was estimated to 48% as compared to 50% in the unadjusted Model I.

Further adjustment for the physical work environment factors changed the estimates more pronounced. The total EF in this fully adjusted Model III was 29%. The estimate for decision authority dropped from 23 to 12%, supervisor support decreased from 13 to 8%, psychological demands from 8 to 6%, and predictability from 7 to 5%. The estimate for skill discretion was reduced from 10% to trifling 3%.

As in article 2, we calculated a Model IV adjusted for SES, for comparison, although we consider it over-adjustment. This decreased the overall estimate of the EF to 19 %, but affected the strongest predictors only marginally, whereas small and negative estimates became even smaller or more negative.

We found no significant interactions between the seven psychosocial factors, and we showed that even the largest possible changes in correlations between the factors had limited impact on the estimates of the total EF calculated by the sum-formula. Repeating analyses when excluding the intervention workplaces or respondents with missing data did not make important changes.

In summary, 5 of 7 factors had significant dose-response associations with absence. The conditions for using the sum-formula proved to be fulfilled. The estimate of the total etiologic fraction was almost unchanged after adjustments for health related factors, somewhat reduced by adjustment for physical work environment, but still counted 29%. Decision authority, supervisor support, demands and predictability had the largest impact.

Article 4: Psychosocial work environment predictors of short and long spells of registered sickness absence during a two-year follow-up

This article describes associations between work environment and absence measured as number of spells of different lengths.

The 1,619 participants with complete follow-up data had 8,829 short spells of sickness absence (1-10 working days) and 507 long spells (>10 days) during the two-year observation period. Short

spells had a mean length of 2.85 days and long spells a mean of 29.7 days. Only 8.8 percent had no absence spells at all. The individual with most absence had 233 absence days during the two years.

Managers and academics had less short absences (mean: 2.04) than all lower socioeconomic groups (4.84-6.72). For long spells, unskilled, semi-skilled and skilled workers had higher rates (0.37-0.40) than all white-collar groups (0.17-0.19).

This study confirmed the general findings of increasing numbers of longer absences with age and with female gender. Among different family types, couples with children under 7 had the highest rate of short absences, whereas single parents had the highest rate of long absences.

For short spells, supervisor support, predictability and meaning of work were all significant predictors in men. Like in women, decision authority was only significant before adjustment for physical work environment. Skill discretion was the only significant predictor for women, but predicted higher absence rates (contrary to expectations, like in article 2).

For long spells, decision authority was a significant predictor of fewer absences in both genders. In women, psychological demands significantly predicted more absences, and in men, supervisor support and predictability were significantly associated with fewer spells.

As in article 2 and 3, we provided further adjustment by SES for comparison, although we consider it over-adjustment. This caused only minor changes (< 4 %) of the estimates for significant predictors, except for the effect of decision authority on long spells in women that was attenuated by 11 %.

Repeating analyses without adjustment for organization and intervention assignment showed mainly minor changes, but the estimates were strengthened for decision authority and short spells in both genders and long spells in women.

In summary, decision authority predicted long spells in both genders, but not short spells when adjusted for physical work environment. Predictability and supervisor support were associated with both short and long spells in men, meaning only with short spells. In women, psychological demands predicted more long absences, and skill discretion more short spells.

Article 5: Workplace levels of Psychosocial Factors as Prospective Predictors of Registered Sickness Absence

In this study workplace mean scores rather than individual scores on the psychosocial work environment scales were considered as potential predictors of individual sickness absence days during the next two years.

Four of the seven psychosocial variables had 10-19% of the variation explained by workplace differences in at least one organisation. In municipal care workplaces differences did not explain more than 7% of the variation for any of the psychosocial factors.

In multilevel Poisson regression adjusted for age, gender, family type, intervention assignment, smoking, alcohol consumption, and BMI, high workplace levels of decision authority predicted low sickness absence in the technical services (RR=0.66, 95% CI=(0.51, 0.86)) and showed similar, but

only borderline significant trends in municipal care (RR=0.71 (0.51; 1.00)) and the pharmaceutical company (RR=0.77 (0.59, 1.00)).

High workplace levels of skill discretion predicted low sickness absence in the pharmaceutical company (RR=0.74 (0.62, 0.88)), and showed a similar, borderline significant trend in the technical services (RR=0.81 (0.65, 1.00)).

In spite of the limited exposure contrast between workplaces in municipal care, psychological demands was close to significance in this organisation (RR=1.22 (1.00, 1.48)). Workplace levels of predictability showed no significant association with absence rates.

Skill discretion was estimated to explain 44% of the variation in absence, decision authority explained 33% and together they explained 52% of the variation in sickness absence between the 52 workplaces.

In summary, decision authority and skill discretion were significant predictors of absence days, when measured as workplace means. By R^2 they were estimated to explain 52% of variation in absence days between the workplaces.

Supplementary results on etiologic fractions

In article 3, etiologic fractions were calculated only for the psychosocial work environment factors as predictors, and only for absence days as outcome. For comparison, we further calculated etiologic fractions for short and long absence spells, and for physical work environment factors and health related behaviours, using the same methods. However, the inter-correlations and interactions are not tested in the same way for physical work environment and health related behaviours. The results are given in table 2 below.

Table 2. Overview of etiologic fractions for psychosocial and physical work environment factors and health related behaviours for absence days and short and long absence spells.

Exposure variables	***Etiologic fractions***		
Psychosocial work environment	**Absence days**	**Short spells (1-10 days)**	**Long spells (>10 days)**
Psychological demands	6.0%	3.1%	10.9%
Skill discretion	2.6%	2.1%	-1.6%
Decision authority	11.9%	5.0%	9.4%
Support from supervisor	8.3%	7.0%	10.5%
Support from colleagues	-1.6%	1.1%	-4.2%
Predictability	5.2%	5.2%	1.4%
Meaning of work	-0.2%	3.0%	-7.6%
Health related behaviours			
Smoking	17.2%	7.7%	21.7%
Alcohol	6.2%	1.4%	7.1%
Body mass index	6.7%	2.2%	9.2%

Physical work environment			
Loud noise	-1.5%	5.9%	-18.2%
Temperature fluctuations	5.9%	2.7%	-0.8%
Cold	7.6%	4.3%	5.4%
Dust	7.0%	4.5%	2.9%
Stooping work position	19.3%	10.1%	22.1%
Twisting the back	21.8%	8.7%	28.5%
Lifting > 30 kg	11.5%	3.0%	7.6%
Pushing/pulling heavy burdens	11.1%	9.2%	2.7%
Repetitive tasks	17.9%	12.3%	20.8%
Heavy physical activity	23.8%	6.4%	23.8%

All calculations adjusted for age, gender, family type, organisation, and intervention assignment. Psychosocial factors further adjusted for health behaviors and physical work environment. Health behavior further adjusted for psychosocial and physical work environment. Physical work environment further adjusted for psychosocial factors and health behavior.

It appears that the two other sets of variables are also important predictors. Just like the psychosocial factors, they seem to predict more long than short spells except from a few physical factors. Smoking appears to be the strongest predictor in its group. Among physical work environment factors, heavy physical activity, twisting the back, stooping work position and repetitive tasks are the strongest predictors, also compared to heavy lifting that is probably the most popular "usual suspect" as potential harmful factor.

To facilitate an overview of the different associations between psychosocial work environment factors and absence, found in this study when using different methods and outcomes, they are summarised in table 3.

Table 3. Associations found in the analyses described above

	Days		**Short spells**		**Long spells**		**Etiologic fractions (%)**			**Workplace levels**
Psychosocial work environment factor	♂ **OR**	♀ **OR**	♂ **OR**	♀ **OR**	♂ **OR**	♀ **OR**	**Days**	**Short spells**	**Long spells**	**Days** R^2
Decision authority	.84	.82			.81	.83	12%	5%	9%	0.33
Psychological demands						1.13	6%	3%	11%	
Skill discretion		1.08*		1.07*			3%			0.44
Supervisor support			.93		.81		8%	7%	11%	
Colleague support										
Predictability	.82		.91		.81		5%	5%		
Meaning at work			.91							

*♂ = Men. ♀ = women. Figure = estimated OR / etiologic fraction / R^2. Blank = no significant association. * Significant associations opposite of the expected direction.*

Six of the seven scales were found to predict at least one outcome measure, the exception being support from colleagues. Decision authority was associated with most outcomes in both genders, and had the largest EF's. Support from supervisor and predictability also had several associations,

but only in men when genders are analysed separately. Although there were 68% women in the study population, supervisor support still had the second highest EF's when the genders were analysed together. Meaning at work only predicted short spells in men.

Psychological demands only predicted long spells in women in the gender-specific analyses, but still showed substantial EF's. Skill discretion showed complex relations, as it seemed to act opposite to the hypothesized in women in the gendered analyses, but in the unisex analysis still came out significant at workplace level, and had a positive EF.

Discussion

As described in the previous paragraphs, the IPAW study was established in co-operation between workplaces in 3 organisations, their occupational health services, and the research group. 52 workplaces were recruited and absence records were retrieved. A questionnaire including a wide range of possible predictors and confounders was developed, tested, and found adequate. Regarding psychosocial work environment, the focus of the questionnaire is on the demand - control - support model, and 2 new scales: predictability and meaning of work.

Summary of results

Based on baseline questionnaire data and 24 months of follow up in the employers' absence registers, 6 of the 7 psychosocial scales predicted at least one absence measure – including the two new scales on predictability and meaning. Together, the psychosocial work environment factors predicted 29% of all absence days in the fully adjusted model. Decision authority that was also previously the best documented psychosocial predictor of absence, proved to be the most prominent predictor. Results for the other scales varied considerably between the genders, and between absence measures.

Adjusting for health related behaviours generally had a very limited impact on the associations with psychosocial factors. Physical work environment factors had a more pronounced effect on the absence, and adjusting for them caused a more substantial reduction of associations with psychosocial factors. Sense of coherence that is an aspect of personality, did not substantially change the results. Social status is known to be strongly related to absence, but as work environment and health related behaviour is believed to be an important part of the pathway, adjusting is likely to be over-control. When doing so for comparison, associations with the psychosocial work environment scales were weakened, but not eliminated.

In summary, preventable factors in working environment and health related behaviour seem to explain substantial parts of absence from work. This study contributes with more details on the role of the psychosocial working environment.

Methodology

The study has a number of strong features but also some shortcomings, which will be discussed below. Among the strong features are the following: 1) The initiative came from the workplaces, not from the researchers. 2) The study includes many work-sites and individuals. 3) The study

covers three quite different sectors: nursing homes (public, predominantly female employees), technical services (public, predominantly male employees), and a pharmaceutical company (private, mixed workforce). 4) The study has a long follow-up period. 5) We have used well-validated psychosocial scales in the questionnaire, including two new scales based on stress theory. 6) The study has 'hard' end-points based on employers' registration of absences.

There are also some possible weaknesses that should be mentioned: 1) Although the workplaces were strongly involved in the initiation of the study, there were limits to the motivation for participation. 2) The organisations did not accept randomization of the intervention- and control-workplaces. 3) There were numerous unforeseen changes at the workplaces during follow-up which may have affected the work environment as well as the outcomes (Olsen et al. 2008). 4) We were not able to get funding for a more detailed, qualitative description of the work environment and the processes of change in the workplaces.

Validity and possible bias

Generalisation: The study population is selected to study the effect of working environment on absence, where it is most marked, in relatively low skilled female and male workers in private and public workplaces. This may limit the ability to generalise when extrapolating to e.g. higher educated employees in other settings or to people not currently having a job.

Selection bias: The attrition analyses showed that those with a high absence rate before baseline had a slightly higher risk of leaving the workplace during follow-up. This will cause some bias in the direction of underestimating the true level of sickness absence, and thereby possibly an underestimation of the effect of work environment on absence. We excluded the very few employees of 60 years or older from analyses, as they were highly selected due to the frequent use of early retirement in lower skilled workers. We have found no indications that employees with a particularly poor or favourable working environment should be more (or less) prone to participate.

Information bias: Absence data were retrieved from the employers' registers and supposed to be objective. It is likely that a small part of real absences were not registered or registered wrong. It seems less likely that non-existent absence should have been registered. In effect, probable errors would tend to underestimate absence and the precision of associations with predictors.

It is a frequent concern that questionnaire answers tend to exaggerate exposures in the work environment, particularly in respondents that feel ill, and therefore perceive the work more demanding. Or in the form of *recall bias*, if symptoms are associated with specific exposures, which are then more often remembered when answering the questionnaire. Any over-reporting of work strains would tend to underestimate the true association with absence, and even more so, if it happens particularly in the most absent. Objective measures of the work environment are not available for comparison.

This study focused on psychosocial work environment, and used validated scales with more questions on each factor. Health related behaviour and physical work environment were measured by single questions that may be less precise measures. This tends to favour positive findings for psychosocial factors at the expense of the other factors.

The consumption of alcohol and tobacco are often assumed to be under-reported because of its known harmful effects and the social desirability of a healthy lifestyle. This may tend to

overestimate the true associations with absence. Under-reporting may not be proportional, as some may deny a moderate consumption and others halve a large use. This would blur the picture and tend to weaken the association.

Confounding: A very large number of factors can affect health and absence. Based on available knowledge, we included a large number of possible confounders in the data collection. Analyses are basically adjusted for age, gender, family type (cohabitation, children), employment organisation, and the intervention or control status of the workplace. As reported above, adjustments were also done for alcohol, tobacco and BMI. If measures of potential confounders were not precise, the adjustment may not be optimal, and this could cause some degree of bias in the estimation of the association between psychosocial working environment and absence.
When developing the questionnaire, we did not find effective measures of diet, which may also be important for other aspect of health than overweight. We asked about levels of physical exercise, but did not find clear associations in preliminary analyses. The same goes for physical work environment factors besides the ten mentioned above. And also a few more psychosocial work environment factors were left out: management quality, harassment, threats and violence. In the time that has passed, other scholars have reported new factors suspected to affect health and absence, as discussed below. To be a confounder, a factor must be associated both with the dependent and independent variable. Theoretical and empirical considerations have shown, that at least one of the associations must be quite strong in order for the factor to exercise confounding that seriously disturbs estimates of associations with the predictors studied (Hernberg 1989). The results above have been adjusted for a wide set of potential confounders, known at the time of designing the questionnaire, and no other factors have yet been reported to explain large parts of the absence. Although some residual confounding can not be ruled out, it is not very likely to be strong.

Mass significance: Many variables are analysed and thus many statistical tests are performed in this study. Although this has not been done as a random "fishing trip", but based on the hypotheses of associations with absence that motivated the study, the conventional 5% significance level implies that around 1 in 20 significant associations being interpreted as causal are really random. With 49 significance tests for psychosocial factors, it is likely that 2 or 3 of the associations found to be significant were not causal. But of course, with 95% acceptance of the null hypothesis, it is much more likely that causal associations have not been acknowledged as such. The pattern of similar associations with more outcome measures in the same gender, and similarities with other studies, gives the impression that the associations found were not merely random.

Power: Even with a relatively large study like this, some cells may have very few observations when analysing more than 20 variables. As the observed odds ratios are not very high, the statistical power of the study may not be sufficient to make all truly causal relations significant. If power had been larger, more findings may have been significant, and thus differences in findings between the genders and between short and long spells could be smaller than it seems.

Possible intervention effects
It would seem likely that an intervention project focusing on reduced absence could stimulate initiatives to get rid of employees with higher than average absence rates in the intervention workplaces. However, the analyses of dropouts seem to reject that this has been the case. This suggests that the project activities in intervention workplaces has been sticking to the intention that the project should primarily improve well-being, and not increase the pressure to fire employees with health problems.

As interventions are intended to reduce the causes for absence, psychosocial work environment and absence may have changed more in the intervention than control workplaces during follow-up. A reduction in absence after the baseline measures of work environment used in the analyses would tend to underestimate the associations. In article 3 and 4, analyses were repeated, while excluding the intervention workplaces. This increased the estimates of EF for decision authority, but otherwise results were practically identical. This limited change may indicate a minor underestimation of true effects because of unaccounted changes of exposure during follow-up, particularly in the intervention workplaces.

Physical work environment
Physical work environment factors were not included in most previous studies on psychosocial factors and absence, but clearly affected the estimates of the psychosocial factors' associations with absence in this study. This may contribute to explain some of the differences in findings on e.g. skill discretion, psychological demands, and social support that were significant predictors in some previous studies.

Etiologic fractions
It is not simple to judge, what level of psychosocial work environment quality that should be considered the goal for prevention or the optimal level. If the dose-response curve is close to linear, the size of the calculated EF is very dependent on the size of the reference group. Comparisons with the most favourable 1% or 10% would yield higher etiologic fractions than a reference of for example 50%. This study found the dose-response patterns quite different between the psychosocial factors, and quartiles were considered a good compromise as the basis of comparison. In practical prevention it is often not possible to achieve optimal conditions in the working environment right away. The approach demonstrated in article 3 can also be used to calculate possible reductions of absence, corresponding to more limited improvements of the work environment.

Socio-economic status
The well-known association between SES and sickness absence is likely to be caused by the unequal distribution between social strata of work environment, health related behaviours, and many other factors. As SES comes before work environment in the causal chain, adjusting for it would be adjusting for a proxy of work environment. There does not seem to be any perfect way to handle this situation.

Health related behaviours
As mentioned in the introduction, stressful work conditions tend to deteriorate health behaviours and thus increase morbidity and absence. As far as this is the case, adjusting for health behaviours may be over-adjustment and contribute to underestimation of the effect of psychosocial factors on absence.

Individual and workplace scores
As the results based on individual scores and workplace means differ, they indicate that it would be relevant to study predictors at both the individual and the workplace level. Many findings have supported the view that the individual's perception and assessment of the work environment is more predictive of effects than less subjective estimates.

A recent Danish study found that a single question on satisfaction with the psychosocial work environment was a better predictor than multiple scales on different aspects of the psychosocial work environment, and that these scales did not further predict absence, when the single question was included in the analyses (Munch-Hansen et al. 2008). This may be because different workplaces have different work environment problems, as also demonstrated in this study's article 5. This finding also seems to support the importance of the individual's perception and assessment of the work environment.

A single question on satisfaction with the work environment may be effective for screening workplaces for work climate problems. But if a need of improvement is found, more diverse and precise measures will be necessary in order to further investigate the problems, and to develop solutions.

Measurements
Follow-up time: Not much is known about, how long it takes for different work environment factors to cause the health effects that increase the sickness absence, or how long the effects last. This makes it hard to choose the optimal periods of follow-up to analyze. Shorter or longer follow-up than used here may explain more of the absence, and it may even differ between different predictors.

Absence measures: Many different measures of incidence and prevalence of absence, including different lengths of spells has been proposed. Hensing et al. have argued that measures focused more on incidence would be wiser for scientific purposes (Hensing et al. 1998). As costs for employers and society are often considered in discussions of absence and prevention, it would be helpful to also report the number of absence days caused or prevented by any factor. It is not possible to decide from the present study, which measures that are most valid or valuable. For preventive purposes, intervention studies are probably needed to decide, what measures that are most informative.

Concerning the limit between short and long spells, no consensus exists. When reasons for the choice of limit is stated (which is not always the case), it seem to depend on local context, e.g. when absence is registered, certified, compensated etc. Along with differences in laws and compensation systems, different length' of absence spells studied, makes comparison between studies from different countries more difficult, and indicates a need for careful consideration when doing so.

Missing data: When respondent leave single questions un-answered, data on these items are missing in the data-set. This could theoretically cause systematic bias. In article 3, we tried to repeat analyses without respondents with missing data. This did not substantially change the results.

Comparison with existing literature

During the last decades, the evidence for a causal influence of the psychosocial work environment on sickness absence has been growing. As confirmed by a recent meta-analysis (Duijts et al. 2007), it seems convincing for job control or decision authority, whereas many other factors are inconclusive because of mixed results (job demands, social support, skill discretion, effort-reward imbalance), or because they have only been tested in one or very few studies (supervisory behaviour, control over work-time, role conflict, role clarity, management quality, emotional demands, demands for hiding emotions, fairness, organizational justice, procedural and interactional

justice, organizational climate, downsizing, expansions, work-family conflict, work-home interference, home-work interference, satisfaction with the psychosocial work environment). As concluded by the comprehensive Swedish review (Allebeck and Mastekaasa 2004) the knowledge on associations between psychosocial workplace factors and sickness absence are not yet fulfilling.

According to Allebeck and Mastekaasa (2004) only few articles are of adequate quality. Only 6 of the 20 articles in their review were published before the IPAW project was initiated in 1996 although counting is not simple, as the review seems to mention only one article on each study, although many studies have produced several articles, reporting different results. Thus, relevant articles like (North et al. 1993) are not counted.

We found an unexpected association between high skill discretion and high absence. This was also found by (Kuijer et al. 2006). As discussed in article 2 this could be due to the employees' perception of "skill discretion" more like straining "demands for change".

According to the Swedish review (Allebeck and Mastekaasa 2004), some *physical work environment factors* were also found to be associated with absence, but with limited evidence. Although this study was not focused on physical work environment, the additional calculations of etiologic fractions above, and the marked effects of adjustments for physical factors indicate that they must have a substantial impact on absence. It would be natural to expect that this impact varies with the type of work studied, and for example affect manual workers more than office workers.

As mentioned in the introduction, a number of studies by Danish colleagues, based on questionnaire exposure data from the Danish Work Environment Cohort Study and record linkage to sick leave compensation by tax-financed social security, showed that physical work environment explained the largest part of absence for more than 8 consecutive weeks, followed by health related behaviours and lastly the psychosocial work environment factors (Lund et al. 2006, Labriola et al. 2006, Christensen et al. 2008). The differences between these results and the ones reported above may also be due to different outcome measures. Absence for more than 8 weeks is much longer than absence measures in this, and many other studies.

Other psychosocial variables have been studied less detailed than the demand-control-support model, as mentioned above. Based on the findings mentioned in the introduction, and on findings on other outcomes, it would seem promising to include at least emotional demands from the COPSOQ questionnaire, effort-reward imbalance, and organizational fairness/justice if a new study was to be designed today.

As *no common cut-off values* exist for the psychosocial factors, results of different studies are very dependent on the context of the single study. For some physical exposures, comparison between studies may seem uncomplicated, e.g. when respondents are asked if they lift burdens of more than 30 kg, this is supposed to have the same impact in different studies, although there may be problems with accuracy, frequency, individual physical fitness, etc. For the psychosocial factors, many different measuring scales exist, and analyses of associations are made in different ways. Furthermore, *it may not be the single factor that is critical*, as the biological pathway through physiological stress processes to disease, is most often stated to be the same. It may be that if any of the factors studied are at a sufficiently straining level, they will elicit a stress response of adequate strength and duration to cause the effects on sickness absence. If this is the case, results will differ according to the *context* in the workplaces of a given study. This may explain the findings on a

single item on satisfaction with psychosocial work environment as a strong predictor of absence (Munch-Hansen et al. 2008).

We found only two scientific articles (Stansfeld et al. 1999, Melchior et al. 2005) and one Danish report (Jensen et al. 2002) that reported *etiologic fractions* for absence, and three studies that reported sufficient data for calculation of EF's (Ala-Mursula et al. 2002, Melchior et al. 2003 and Moreau et al. 2003). The findings were in the range from 6% - 38%, compared to the 29% in this study. We included seven psychosocial variables, and used the most favourable quartile as reference, whereas the other studies included between one and four psychosocial variables and some used the median or the most favourable tertile as reference. This will favour a higher EF in our study. On the other hand, we adjusted the analyses by a larger set of physical factors, which reduced the estimate considerably. The Danish report (Jensen et al. 2002) found that the EF differed markedly by socio-economic strata, from 22% in managers and academics to 49% in unskilled workers. A social gradient was also found in the GAZEL study, without giving figures for the attributable fraction (Melchior et al. 2005).

We did not study *diagnoses* of the employees on sick-leave. Partly because we did not consider it relevant for the study, partly because it was not feasible. As mentioned in the introduction, Danish employers are not allowed to have information on diagnoses when employees are sick-listed. And not all relevant diagnoses are reported to the case-manager.

Employees with common *mental disorders* have more absence than others (Goetzel et al. 2004, Savikko et al. 2001, Borritz et al. 2006). Even if we had asked the respondents or their general practitioners for diagnoses, information may have been biased. Depression, anxiety and other common mental health problems are still often perceived as stigmatising and thus frequently underreported. A recent Danish report found that 48% of the employees on long-term sickness absence (more than 8 weeks) had psychological problems like depression, anxiety, OCD, or personality disorders diagnosed at a psychiatric interview. (Søgaard 2008). 22% did not report such diagnoses to the case manager in the municipality (46% of those with a diagnosis).

A special problem is related to mental disorders. Just like work-related musculoskeletal disorders are believed to increase the reporting of physically demanding work environment, the psychosocial work environment is likely to be perceived as more demanding if the worker has even moderate mental health problems like sub-clinical depression, anxiety etc. In fact, it has been found that stressful work conditions are associated with poor mental health (Stansfeld and Candy 2006, Netterstrøm et al. 2008, Bonde 2008). Even though the association goes both ways, the pathway from work strain to mental health is demonstrated to be stronger than the reverse (de Lange et al. 2004).

Although the "reverse causality" part of this association can cause some bias in the estimation of the association between psychosocial work environment and sickness absence, the review by Stansfeld and Candy (2006) argues convincingly that the reverse association can not explain the observed effect of psychosocial work factors on mental health and thus on sickness absence because of this.

What this study adds

The IPAW study and the analyses included in this PhD were built on the fundament created by much of the literature mentioned in the introduction. But it has also made a number of new and unique contributions:

1) Data from a cohort of 2730, predominantly female and low skill workers, including 24 months of follow-up in absence data from employers registers, from 52 public and private workplaces, in a Danish context.
2) Development and testing of a questionnaire, including a wide range of potential confounders, and 2 new scales on predictability at work and meaning of work that were later included in the COPSOQ questionnaire, and results on their association with registered sickness absence.
3) Development of a model (figure 1) to assist overview over the possible pathways from work environment to sickness absence, and to help explain why the association between work environment and absence include much more than absence due to "traditional" occupational injuries and diseases.
4) Etiologic fractions estimating how much of the sickness absence that was caused by psychosocial work environment. This is rarely available in other studies.
5) Separate results by gender, for both absence days and for short and long absence spells.
6) Comparable results for absence days calculated with individual scores of psychosocial work environment factors replaced by workplace means as measure of exposure.
7) Some contributions to the understanding of conflicting findings in earlier studies:
    a. Detection of marked confounding by physical work environment that was only controlled for in few other studies
    b. The importance of local contextual factors like laws and practices, compensation schemes etc.
    c. The comment from participants that what we as researchers consider "skill discretion" may be perceived by workers as straining "demands for change".

Perspectives

Prevention
During the last decade, many workplaces have made an effort to improve the psychosocial work environment. Many casuistic reports on decreased absence, increased productivity, and growing satisfaction are given in popular media, but proper scientific evaluations of preventive interventions are still very limited. The findings from this study, and the other ones mentioned, indicate that substantial parts of the absence could actually be prevented by optimising the psychosocial (and physical) working conditions. It should be recommended to act on the present level of knowledge, but as concrete and useful research-based guidance is still scarce, effects should be evaluated and documented whenever possible, and the results should be made available to the public.
The best documented knowledge on work environment and absence could probably have large impacts on practice if included in the professional training of employees and leaders.

Research
Although limited, the research in this field confirm that psychosocial work environment factors that are critical in the given context, may limit the health, well-being, motivation, presence and productivity of employees.

There is still room for improvement of the quality of the research in this field. Methodological points discussed above must be taken seriously, and new hypotheses on predicting factors must be tested. We need to elucidate further the reasons for conflicting results of different studies. Any study should include predictors of relevance for the specific population, organisation, and job-types studied. In order to get a better understanding, we also need to learn more about the time

perspectives from exposure to effect, and the duration of the effects. This must be used for planning of adequate follow-up analyses. We also need further understanding of the mechanisms through which work environment affects health and behaviour.
Basic details on local systems should be included in study descriptions, since differences in regulations and compensations systems may partly explain differences between findings in studies performed in different societies.

However, first of all, it is important to change path from primarily observational studies into intervention studies, to properly evaluate the effects of preventive actions, and to test if the associations found in observational studies can be transformed into preventing and reducing absence in contemporary work-life. To be able to separate possible program failure (the "pill" don't work) from implementation failure (the "patient" didn't take the pill), proper interpretation of intervention studies require careful process documentation and evaluation. As prevention in this field is not simple, good studies of implementation and dissemination will be increasingly important as evidence is growing.

As workplaces are subject to many other changes than the ones intended in intervention studies (Olsen et al. 2008), it is also necessary to develop methods to cope with this in designing, analysing and interpreting intervention studies.

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The three organisations paid for consultants and other costs for interventions, working time for meetings etc. In the municipal organisations, the costs for consultants were approximately 0.3 million Euros. The pharmaceutical company used consultants from their own human resources department and no economical accounts were available for this. Figures for the working time used for meetings and other intervention activities were not available.

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Appendices (Articles 1-5)

Article 1:
Nielsen ML, Kristensen TS, Smith-Hansen L. The Intervention Project on Absence and Well-being (IPAW): Design and results from the baseline of a 5-year study. Work & Stress 2002;16(3):191-206.

Article 2:
Nielsen ML, Rugulies R, Christensen KB, Smith-Hansen L, Bjorner JB, Kristensen TS. Impact of the psychosocial work environment on registered absence from work: A two-year longitudinal study using the IPAW cohort. Work & Stress 2004;18(4):323-335.

Article 3:
Nielsen ML, Rugulies R, Smith-Hansen L, Christensen KB, Kristensen TS. Psychosocial work environment and registered absence from work. Estimating the etiologic fraction. American Journal of Industrial Medicine, 2006;49(3):187-196.

Article 4:
Nielsen ML, Rugulies R, Christensen KB, Smith-Hansen L, Kristensen TS. Psychosocial work environment predictors of short and long spells of registered sickness absence during a two-year follow-up. Journal of Occupational and Environmental Medicine, 2006;48(6):591-598.

Article 5:
Christensen KB, Nielsen ML, Rugulies R, Smith-Hansen L, Kristensen TS. Workplace Levels of Psychosocial Factors as Predictors of Registered Sickness Absence. Journal of Occupational and Environmental Medicine, 2005;47(9):933-940.

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The Intervention Project on Absence and Well-being (IPAW): Design and results from the baseline of a 5-year study

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Keywords: *Psychosocial factors; Intervention study; Absence from work; Stress; Well-being; Work environment.*

This paper presents the background, design and baseline results of the Intervention Project on Absence and Well-being (IPAW). IPAW is a 5-year psychosocial work environment intervention study including 22 intervention and 30 control work-sites from three different types of work-site (a large pharmaceutical company, municipal technical services, and municipal nursing homes) in Copenhagen, Denmark. The baseline survey reported in this paper was conducted in 1996–97, and the cohort was followed until 2002. Interventions took place during 1996–98 at the organizational and interpersonal level and focused on psychological demands, social support, control, meaning of work, and predictability. The main end-points are self-rated health, perceived stress, absence from work, job satisfaction, and labour turnover. Analyses of the baseline data show good reliability of the psychosocial scales and a number of clear associations between psychosocial work environment factors and health indicators. The baseline data also demonstrate several discrepancies between the planned design of the study and the actual implementation of the project in practice.

1. Introduction

During the last 15–20 years a substantial number of reviews of occupational stress intervention studies (Burke, 1993; DeFrank & Cooper, 1987; Ganster & Schaubroeck, 1991; Hurrell & Murphey, 1996; Ivancevich & Matteson, 1986; Ivancevich, Matteson, Freedman, & Phillips, 1990; Karasek, 1992; Kompier, Geurts, Gründemann, Vink, & Smulders, 1998; Kompier & Kristensen, 2001; Murphey, 1984; Parkes & Sparkes, 1998; van der Hek & Plomp, 1997) and health promotion intervention studies (Heaney & Goetzel, 1997; Kasl & Serxner, 1992; Pellertier, 1993, 1996; Wilson, Holman, & Hammock, 1996) have been published. Although these reviews have analysed different types of intervention studies and used different methods, there seems to be almost total agreement on the following conclusions: (1) Results are mixed—none of the specific fields of intervention (such as health promotion, stress management or organizational intervention) yields a clear picture with regard to the effects of the intervention. (2) Although study methods have been improved during the last two decades, most studies have low or medium methodological quality.

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(3) Most of the studies have no clear theoretical foundation and many of the concepts are not clearly defined. (4) A large majority of the studies have focused on interventions and outcomes at the individual level and neglected organizational factors.

At the National Institute of Occupational Health (NIOH) in Copenhagen, Denmark, we started a large psychosocial intervention study in 1996: The Intervention Project on Absence and Well-being (IPAW). The aim of this paper is to present the background, design and some baseline results from IPAW. Having studied many of the reviews mentioned above, it was our intention to perform a high quality intervention study with an explicit theoretical foundation, a long follow-up, and an optimal design. Our encounters with the realities of the participating workplaces taught us a few lessons about the art of compromise. Thus, a further aim of this paper is to demonstrate why we could not always live up to the ideal textbook norms.

2. The initiation of IPAW

The initiative to launch an intervention study on absence and well-being originally came from three occupational health services (OHSs) in the Copenhagen area. Each of these OHSs had been approached by a workplace where absence was 'too high': a large pharmaceutical company, the municipal technical services of Copenhagen and municipal nursing homes in Copenhagen. Each of these workplaces consist of local units or departments, here called 'the work-sites'. These work-sites became the units of intervention.

At NIOH we were struck by the fact that the three different OHSs had been approached by workplaces with the same problem. At all the workplaces management had tried to solve the absence problem through individual level interventions (such as meetings with individual employees with 'too many' absence days). These initiatives had not had the desired effect, and the employers had then agreed with the representatives of the workers that there was a problem with the 'psychosocial work environment'. Both parties at the three workplaces hoped that the OHSs could come up with a solution to the problem. Thus, the initiative was supported by employers as well as employees, but for different reasons: the employers hoped for lower absence rates while the employees hoped for better psychosocial working conditions.

After a few meetings with representatives from the work-sites it was decided to start a common project, IPAW, and three project committees with representatives from management and employees were established. It is important to note that for each of the three different categories of participants, the project includes only their respective part of the study. They do not even use the name IPAW, and they have never actually met each other. For us it was important that the participating work-sites had a 'feeling of ownership' in relation to the project (Israel, Schurman, Hugentobler, & House, 1992), since this would be an important aspect of the necessary commitment to the whole intervention process. In practice it turned out that although the work-sites had chosen to participate, many workers and quite a few middle managers had, in fact, not been involved in the decision process and had some times not even been informed.

3. The design of IPAW

The basic design of IPAW is shown in figure 1. Three categories of work-sites were included: high-absence intervention work-sites, high-absence control work-sites, and low-absence control work-sites. We included low-absence control work-sites for a number of reasons. First, we wanted to be able to study the variation in psychosocial factors between

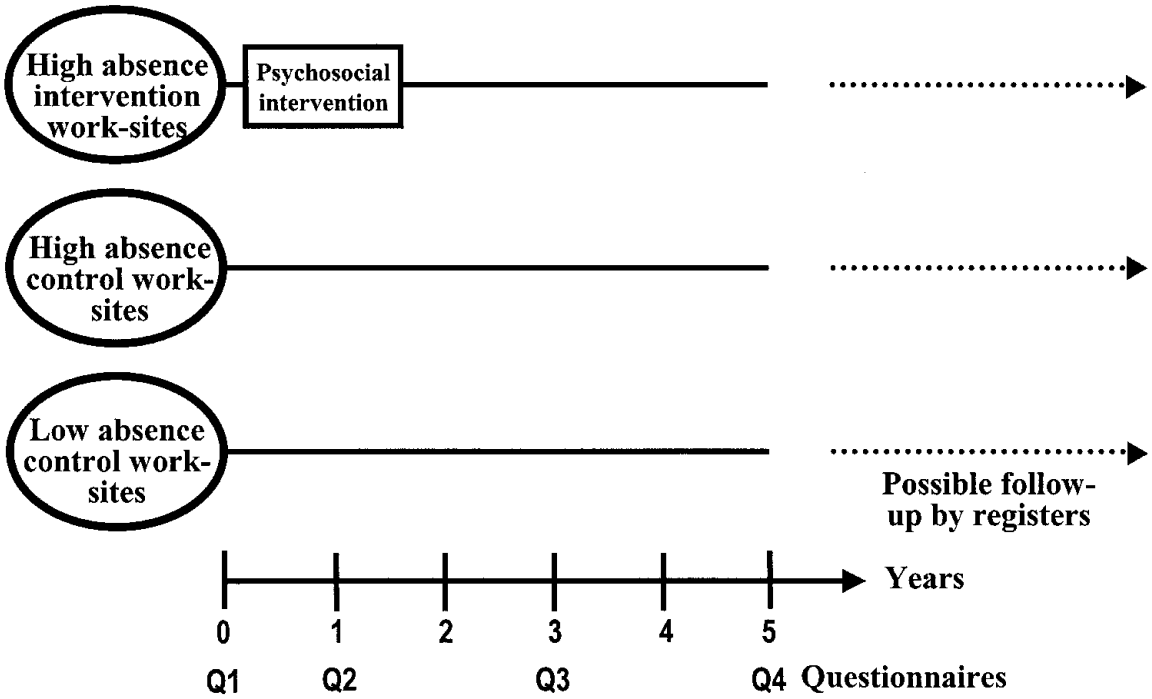

Figure 1. The design of the Intervention Project on Absence and Well-being (IPAW).

high- and low-absence work-sites at baseline and during follow-up. Second, we thought it important to be able to study possible regression to the mean among high- as well as low-absence work-sites. Third, we thought that it would be interesting to study the low-absence work-sites prospectively in order to see if they could keep the absence rates low during a longer period. In principle we wanted to pick two control work-sites (one with high absence and one with low absence) for each of the intervention work-sites. As we shall see below, it was not possible to carry out this intention in practice.

Data were collected via questionnaires at baseline (Q1), and after 1, 3 and 5 years (Q2, Q3 and Q4). During summer 2002, the final 5-year follow-up questionnaire survey was ongoing and absence data up to 2001 were being collected.

After Q4 it will be possible to follow the participants in various registers (such as the national death and hospitalization registers) via Personal Registration Numbers issued to all Danes by the authorities and used for identification in registers (the dotted lines in figure 1).

Our basic model of work, health and absence is a rather simple one (figure 2). The health of the employee is influenced by work as well as a number of other factors (lifestyle, personality, social factors, etc.), and absence is believed to be influenced not only by the health status of the employee but also by work and non-work factors irrespective of health. This means that absence is not seen as a simple reflection of a person's health or disease status but as a form of behaviour, which reflects the health as well as the broader life circumstances of the person (Kivimäki, Vahtera, Thomson, Griffiths, Cox, & Pentti, 1997; Kristensen, 1991; North, Syme, Feeney, Head, Shipley, & Marmot, 1993; Voss, Floderus, & Diderichsen, 2001).

The theoretical model of the IPAW intervention is shown in figure 3. A systematic psychosocial intervention at the organizational and interpersonal level was planned to take place at a number of intervention work-sites. The aim of the interventions was to improve the psychosocial work environment by focusing on five basic dimensions of work stressors: psychological demands, control, meaning of work, predictability and social support. The choice of these five dimensions was based on general stress theory (Frankenhaeuser, 1991;

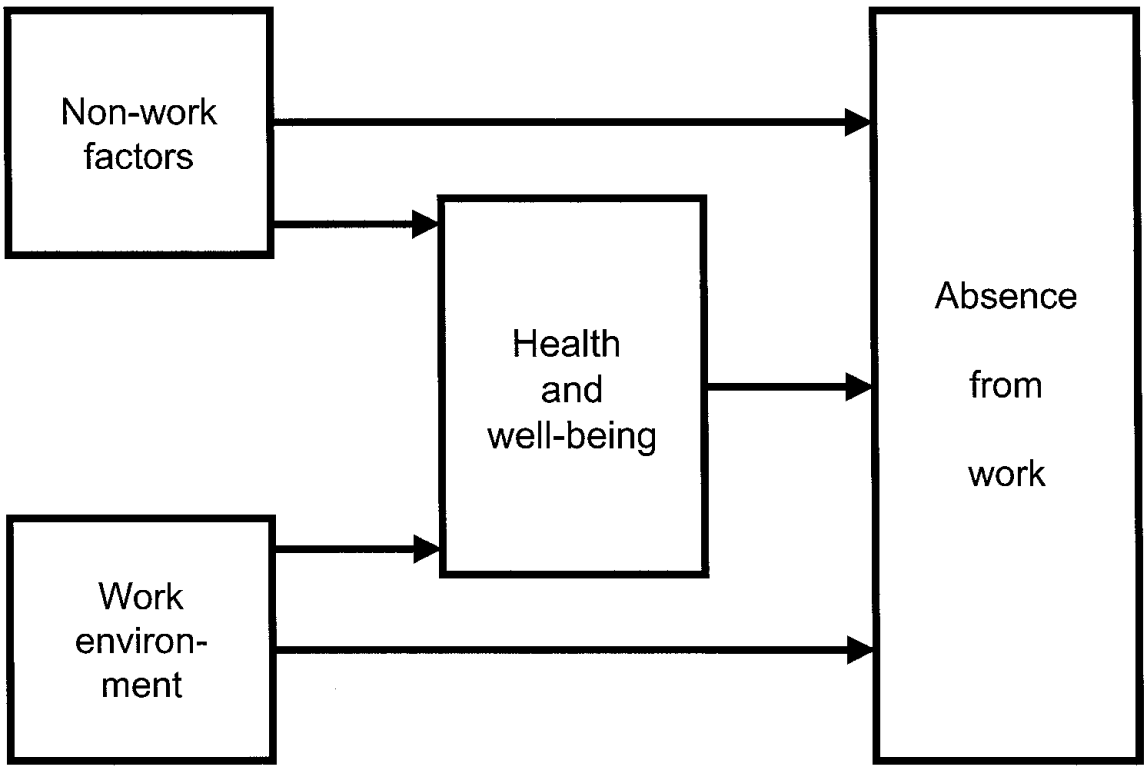

Figure 2. The basic model of absence from work of the IPAW study.

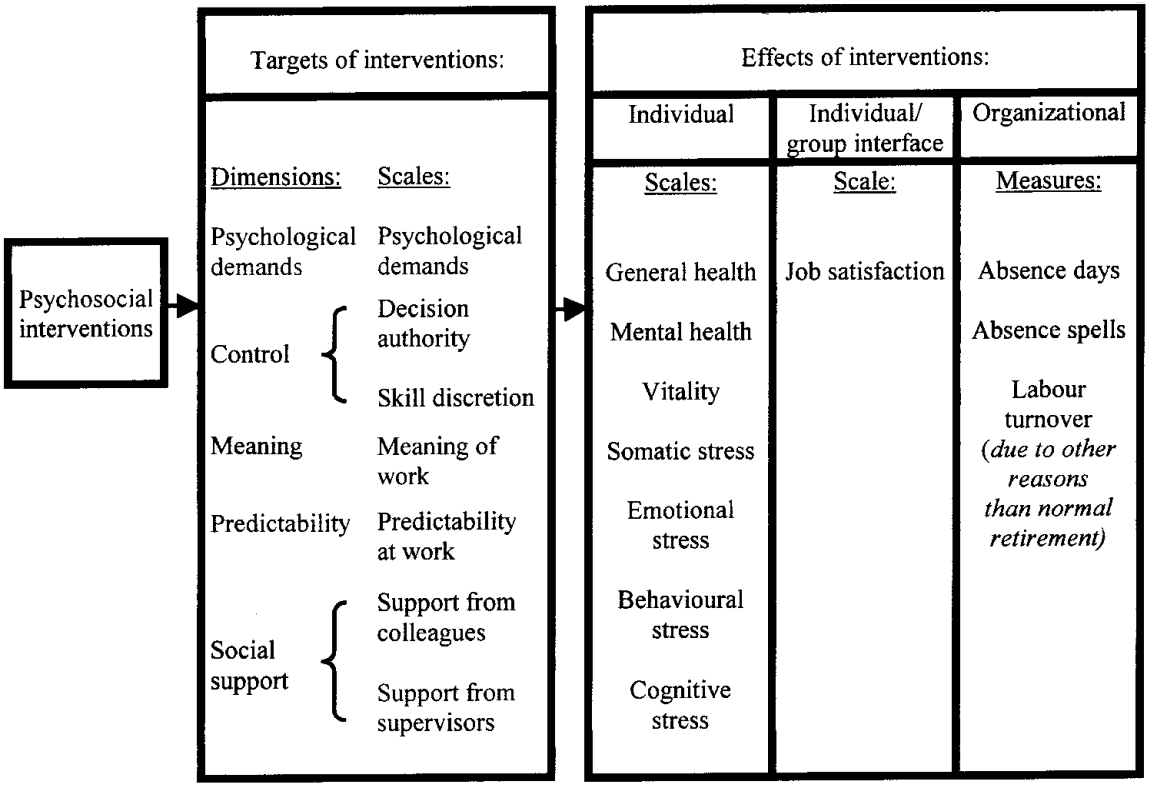

Figure 3. The basic analytical model of the IPAW study.

Johnson & Johansson, 1991; Karasek & Theorell, 1990; Levi, 1984; Sapolsky, 1994). In IPAW, these dimensions were measured with seven questionnaire-based scales as indicated in figure 3. Following the Karasek tradition, control was divided into the two measures

decision authority and skill discretion. Likewise, support was measured as support from colleagues and supervisors, respectively.

The measures of the two dimensions 'meaning of work' and 'predictability' were developed by us. Meaning of work is present if the respondent finds the work tasks meaningful and feels that the work is important and useful for others. Predictability refers to relevant and useful information about major future events at the work-site, such as changes in the organization of work, new technology, physical changes, etc.

According to our basic model, improvement of the psychosocial work environment is assumed to improve job satisfaction, health, and psychological well-being. Health and psychological well-being were measured with seven scales as shown in the figure. Finally, absence from work and labour turnover were expected to decrease as a result of improved working conditions, higher job satisfaction, and improved health and psychological well-being.

In our communication with the project committees the goals of the interventions were defined as in figure 3: high control, high support, high meaning, high predictability, and *suitable* demands. This combination of key psychosocial factors at work comes very close to the concept 'developmental work' ('udviklende arbejde'), which combines development of individual, work and organization and is a well-known concept in the Danish labour market (Hvid, 1999).

Each of the intervention work-sites appointed consultants with expertise in the field of psychosocial factors at work to assist the work-site with the intervention process. The interventions were based on four different types of input: the basic paradigm of the five dimensions, the expertise and experience of the consultants, the wishes and resources of the work-sites, and the questionnaire results from the baseline study (in particular the results concerning the basic five dimensions). Thus, the type of interventions we are talking about here are a mixture of theory driven and practice based, between bottom-up and top-down, and between experts' concepts and a participatory approach. We applied for research money to follow and describe the intervention processes with the use of qualitative methods (Griffiths, 1999) but did not succeed, since the funds did not find the topic 'scientifically relevant'. Instead we chose to assess the interventions with a short, standardized instrument.

4. Participants and methods

4.1. *Respondents and work-sites*

The IPAW baseline questionnaire was sent to all the employees at the selected work-sites from 5 May 1996 to 14 April 1997. We obtained the private addresses of the employees from the employers, and the questionnaire was sent to each employee with an accompanying letter from the project committee and a stamped envelope for return of the questionnaire to NIOH. The non-responders received two reminders, the second with a new questionnaire. We contacted supervisors and shop stewards at work-sites with low response rates in order to discuss possible misunderstandings and other reasons for non-response. It was made clear to all participants that IPAW uses Personal Registration Numbers, as confidentiality was a cause for some concern at a number of the work-sites.

Table 1 shows the distribution of respondents and work-sites at intervention and control work-sites and at the three types of workplaces. We intended to have an equal distribution between the three groups of work-sites: intervention work-sites, control work-sites with high absence and control work-sites with low absence. This was, as already mentioned, not accomplished in practice. In the municipal technical services there turned out to be only four intervention work-sites against 13 control work-sites while the situation was reversed in the nursing homes, with 13 intervention work-sites and only nine control

Table 1. Number of participating work-sites and employees in the baseline IPAW study.

	Work-sites (*n*)	Respondents (*n*)	Response rate (%)
Pharmaceutical company			
Intervention	5	399	76
Control, high absence	5	246	76
Control, low absence	3	86	85
Total	13	731	77
Municipal technical services			
Intervention	4	128	77
Control, high absence	5	135	69
Control, low absence	8	80	66
Total	17	343	71
Nursing homes			
Intervention	13	654	81
Control, high absence	4	155	75
Control, low absence	5	185	69
Total	22	994	77
Combined total	52	2,068	76

work-sites. At the pharmaceutical company there was a rather equal distribution of work-sites, but not of employees.

The response rates varied from 66% in the low absence control work-sites of the technical services to 85% in the low absence control work-sites of the pharmaceutical company. For the individual work-sites the response rates varied from 25% to 100%. Only four work-sites were below 50% and three of these were small control work-sites. It should be noted that in IPAW there is a difference between 'respondents' and 'participants'. While 2068 employees filled out the baseline questionnaire, all 2721 employees at the 52 work-sites were, in principle, participants in IPAW, and 1501 of these worked at the intervention work-sites at baseline.

4.2. *Psychosocial scales*

Table 2 shows some characteristics of the most important scales employed in IPAW. The questions in the scales on psychological demands, decision authority, skill discretion, support from colleagues and supervisors, and job satisfaction were translated from the Whitehall II study (Marmot *et al.*, 1991). The scales on meaning of work and predictability were developed at NIOH by us. The three scales from the Short Form 36 (SF-36) (Ware, Snow, Kosinski, & Gandek, 1993) questionnaire have been thoroughly translated, tested and validated by the Danish SF-36 group (Bjorner, Thunedborg, Kristensen, Modvig, & Bech, 1998). Finally, the four scales on behavioural stress, somatic stress, emotional stress, and cognitive stress have been developed and tested by Setterlind in Sweden (Setterlind & Larsson, 1995) and translated by us.

The individual questions in the scales shown in table 2 have between four and six response categories, and the scores were calculated by adding the scores of all the items and then transforming the sum to a standardized score ranging from 0 to 100 for each scale. If there were missing scores on single questions we used the convention of the SF-36 questionnaire (Ware *et al.*, 1993). According to this convention a standardized score on a scale is calculated for a person if the person has answered at least half of the questions of

Table 2. Characteristics of the psychosocial scales used in the IPAW baseline study.

Scale	Number of items	Cronbach's α	Inter-item correlations	Mean	SD	Percentage missing (%)
Work environment						
Psychological demands	2	.56	.41	57.9	21.7	0.7
Decision authority	8	.81	.18–.56	66.7	20.6	0.5
Skill discretion	4	.69	.30–.47	75.8	18.4	0.5
Support from colleagues	2	.76	.61	76.7	23.8	1.0
Support from supervisors	2	.84	.72	68.9	27.6	0.8
Meaning of work	4	.78	.37–.59	76.6	16.3	1.0
Predictability	2	.75	.60	50.8	24.5	1.6
Satisfaction						
Job satisfaction	7	.81	.23–.64	62.3	15.6	0.5
Health and well-being						
General health (SF-36)	5	.73	.23–.65	76.1	17.1	4.2
Vitality (SF-36)	4	.83	.43–.76	62.4	18.5	1.6
Mental health (SF-36)	5	.82	.41–.67	77.4	15.6	1.6
Behavioural stress	7	.84	.18–.68	12.4	15.4	1.5
Somatic stress	5	.72	.26–.49	11.5	14.5	1.6
Emotional stress	8	.88	.33–.66	22.5	17.7	1.2
Cognitive stress	4	.86	.52–.69	22.9	18.3	1.3

the scale. The missing items are given the average scores of the other items of the scale. One scale (the General Health scale of the SF-36) had an unsatisfactorily high proportion of respondents classified as missing (4.2%). This was due to a high proportion of missing values on the last four questions in this scale. Our analyses show that the non-response rate on these questions increased sharply with increasing age of the respondent.

The Cronbach's α for internal reliability is above the recommended value of .70 for most of the scales. Two, rather short, scales constitute the exceptions: psychological demands (.56) and skill discretion (.69). It is well known that the α is lower, the lower the number of items in a scale.

The orientation of the scales is in accordance with the labels of the scales. This means that a high value for, for example, vitality means that the person has a high level of energy and vitality, while a high value for, for example, cognitive stress means that the person has difficulties with concentrating and remembering. Hence, a person with a high level of well-being will have high values on the three SF-36 scales and low values on the four Setterlind stress scales. For the work environment scales, a good psychosocial work environment corresponds to high scale values for all scales except psychological demands.

The five basic dimensions of IPAW (psychological demands, control, social support, meaning, and predictability) were measured with the seven scales at the top of table 2. (Two of the dimensions were operationalized by two scales each, the other dimensions by one each). The extent to which the psychosocial work environment was improved at the intervention work-sites is primarily going to be analysed by means of these seven scales.

4.3. *Measurement of absence from work*

Absence from work was measured in two ways. In the questionnaire we have asked the respondents to indicate the number of sickness absence days and absence spells during the last 12 months before filling out the questionnaire. We are also receiving registered absence data from all the work-sites participating in IPAW during the whole study period.

Absence data for the first three years have been received now but we are still checking inconsistencies and missing values and persons. For this reason we will only include the questionnaire data on absence in the present paper.

In order to interpret data on absence it is necessary to have a few pieces of information about the rules regarding sickness absence benefits. In Denmark, white-collar workers receive full salary during absence. Blue-collar workers normally receive 90% of the normal salary with a maximum of US$12 per hour (January 2001). Employers pay for the first 2 weeks, and after this the expenses are covered by the state. Certification from a medical doctor may be required by the employer, but normally this only happens after longer periods of absence or if the employee has many short absence spells (so-called 'Monday and Friday disease'). In the public sector it used to be normal and legal to fire persons with more than 120 days of absence during a 12-months' period, but this rule has been abolished recently. Many private employers fire employees with 'too high' absence rates, in particular if the employer feels that the employee may be misusing the system by being absent without really being ill. By firing workers with 'too high' absence rates, absenteeism is reduced in two ways: persons with high absence are leaving the workplace, and the remaining workers may reduce their absences in order to avoid being sacked.

5. Results

5.1. *Work environment factors*

The intercorrelations between the seven basic psychosocial work environment scales of IPAW at baseline are shown in table 3. The scale for psychological demands shows a positive association with skill discretion, no association with meaning of work, and negative associations with the other four scales. The remaining six scales (all indicators of 'good' psychosocial working conditions) show positive, but moderate, intercorrelations. It is of importance that none of the correlations is above .50. It is also noteworthy that the two scales that are often combined into one in the Karasek (1992) tradition (decision authority and skill discretion) correlate moderately with each other ($r = .35$) and quite differently with the five other scales. For this reason the two scales have not been combined in this study.

5.2. *Health indicators*

The intercorrelations between the health indicators at baseline are demonstrated in table 4. All correlations are statistically significant and in the expected direction. Three of the correlations are above .70: the correlations between vitality and mental health, between emotional stress and mental health, and between absence days and absence spells. The general health scale shows the highest correlations with the measures of absence, while behavioural and cognitive stress show the lowest.

5.3. *Associations between work and health*

The associations between the seven basic psychosocial work environment scales and the nine health indicators are shown in table 5. If we take a look at the seven scales for health and psychological well-being first, all the associations are in the expected direction. In general, the scale for skill discretion shows weaker associations than the other scales, and five of the seven associations are not statistically significant for this scale. Seen across the seven indicators of health and well-being, predictability, meaning of work, and psychological demands show

Table 3. Intercorrelations of the psychosocial factors in the IPAW baseline study.

Psychosocial factors	Decision authority	Skill discretion	Support from colleagues	Support from supervisors	Meaning of work	Predictability
Psychological demands	− .11***	.17***	− .12***	− .13***	.04	− .15***
Decision authority		.35***	.15***	.30***	.30***	.32***
Skill discretion			.11***	.15***	.38***	.18***
Support from colleagues				.42***	.18***	.18***
Support from supervisors					.26***	.44***
Meaning of work						.42***

Spearman correlation coefficients: *$p < .05$, **$p < .01$, ***$p < .001$.

Table 4. Intercorrelations of the health indicators in the IPAW baseline study.

Health indicators	Vitality	Mental health	Behavioural stress	Somatic stress	Emotional stress	Cognitive stress	Absence days	Absence spells
General health	.37***	.34***	− .26***	− .33***	− .37***	− .31***	− .30***	− .26***
Vitality		.75***	− .64***	− .37***	− .65***	− .52***	− .19***	− .18***
Mental health			− .69***	− .37***	− .71***	− .52***	− .17***	− .17***
Behavioural stress				.32***	.62***	.48***	.12***	.13***
Somatic stress					.51***	.42***	.18***	.15***
Emotional stress						.69***	.19***	.17***
Cognitive stress							.10***	.10***
Absence days								.75***

Spearman correlation coefficients: *$p < .05$, **$p < .01$, ***$p < .001$.

Table 5. Bivariate associations between the psychosocial factors and the health indicators in the IPAW baseline study.

	Health indicators								
Psychosocial factors	General health	Vitality	Mental health	Behavioural stress	Somatic stress	Emotional stress	Cognitive stress	Absence days	Absence spells
Psychological demands	− .06**	− .21***	− .17***	.17***	.10***	.19***	.18***	− .02	− .02
Decision authority	.12***	.19***	.16***	− .16***	− .08***	− .17***	− .12***	− .16***	− .14***
Skill discretion	.10***	.06**	.01	− .03	− .00	− .04	− .02	− .15***	− .09***
Support from colleagues	.10***	.11***	.10***	− .14***	− .10***	− .11***	− .09***	− .03	− .00
Support from supervisors	.11***	.15***	.13***	− .17***	− .08***	− .15***	− .11***	− .10***	− .09***
Meaning of work	.16***	.21***	.18***	− .15***	− .07***	− .14***	− .15***	− .10***	− .08***
Predictability	.15***	.22***	.18***	− .18***	− .11***	− .19***	− .16***	− .16***	− .14***

Spearman correlation coefficients: *$p < .05$, **$p < .01$, ***$p < .001$.

the strongest correlations. For the self-reported measures of absence the highest correlations appear to be with decision authority, skill discretion and predictability. Support from colleagues and psychological demands were not associated with absence at baseline.

5.4. *Self-reported absence at intervention and control work-sites at baseline*

Finally, table 6 shows the average number of self-reported absence days and spells for the different groups of work-sites. The average number of absence days was consistently lower in the 'low absence control work-sites' but the differences were not very large. With regard to absence spells, the differences were as expected in the nursing homes and the pharmaceutical company, but in the municipal technical services the three groups of work-sites showed very similar levels. The two types of public workplaces (nursing homes and technical services) seemed to have higher absence rates than the private pharmaceutical company (about 13–14 days per year compared with about 9 days, respectively).

6. Discussion

6.1. *The strong features of the IPAW study*

IPAW is a 5-year prospective intervention study and we have a long way to go before we can draw the final conclusions, but we still feel that a number of preliminary conclusions are warranted. The study has a number of strong features but also some shortcomings, which will be discussed below. Among the strong features are the following: (1) The initiative came from the workplaces, not from the researchers. (2) The study has a long follow-up period. (3) The study includes intervention as well as comparison work-sites. (4) The study covers three quite different sectors: nursing homes (predominantly female employees), technical services (predominantly male employees), and a pharmaceutical company (mixed composition). (5) The intervention is theory-based. (6) The study has a number of 'hard' as well as 'soft' end-points. (7) The interventions were carried out with the assistance of professional consultants, not by the researchers themselves. (8) The use of Personal Registration Numbers makes it possible to follow up the participants in the

Table 6. Mean number of self-reported absence days and spells for intervention and control work-sites in the IPAW baseline study.

		Absence days during the year 1996			Absence spells (of any length)		
		Intervention work-sites	Control work-sites		Intervention work-sites	Control work-sites	
			High absence	Low absence		High absence	Low absence
Pharmaceutical company	Mean	10.7	9.4	8.8	2.0	2.2	1.7
	SEM	0.9	0.8	1.8	0.1	0.1	0.2
	n	391	234	82	383	227	83
Technical services	Mean	14.7	14.2	13.6	2.1	2.3	2.2
	SEM	1.9	2.0	1.6	0.1	0.2	0.2
	n	124	128	78	125	128	77
Nursing homes	Mean	13.7	14.8	10.9	2.1	2.1	1.8
	SEM	0.9	2.5	1.1	0.1	0.2	0.1
	n	629	150	175	610	149	172

Hospital and Death Registries. (9) We have used well-validated psychosocial scales in the questionnaire. (10) The study includes many work-sites and individuals.

6.2. *Shortcomings of the study: the discrepancy between theory and practice in intervention research*
While we find the above strong features of IPAW worth noting we also think that it is important to mention and discuss the weak features and shortcomings of the study. We have already mentioned one of the shortcomings: we have not been able to raise research grants for a continuous study of the intervention processes at the intervention work-sites and of the 'natural' course of events at the control work-sites. Instead, we have chosen a cheaper—and more superficial—method of gathering information on the intervention processes. We will return to this topic in a later paper.

Another shortcoming of the project is demonstrated by tables 1 and 6. The allocation of work-sites to the three 'experimental groups' (intervention, control with high absence rates, and control with low absence rates) has been far from perfect. In principle, we wanted the three groups to have about equal sizes (with regard to employees as well as work-sites), we wanted the work-sites in the three groups to be 'similar' in all respects (except absence rates), and we wanted the absence rates at the low absence control work-sites to be clearly lower than at the other work-sites. The discrepancies between theory and practice become evident when we study the two tables. For instance, table 1 shows that there were 13 nursing home intervention work-sites, which means that there should have been 26 control work-sites. In fact there were only 9. There should have been about 800 employee respondents at the control work-sites at the pharmaceutical company, but there were only 332. Similarly, the contrasts with regard to absence rates were not what we intended them to be. Supervisors and workers had told us about dramatic differences in absence rates between departments and between individual nursing homes. Table 6, however, demonstrates very small differences between 'high absence' and 'low absence' work-sites. (This picture may change when we get the results from the official absence registers for the two years preceding baseline, so this conclusion should be considered to be temporary).

These discrepancies between the ideal and the actual study design demonstrate a simple fact, which should never be forgotten by researchers who do occupational intervention research: the workplaces are not laboratories designed for controlled intervention studies. The goals of the workplaces are to produce goods and services as efficiently as possible, and research goals may be accepted only as long as they do not interfere with these production goals.

When the work-sites were selected for intervention and control groups in IPAW, a number of very real considerations prevented the ideal design plans from being followed. For example, when the Occupational Health Services (OHSs) presented the IPAW project to the representatives from the nursing homes, a very large proportion wanted to participate as intervention work-sites. The OHS could not say no to nursing homes that wanted help for improving the psychosocial working conditions, and the result was that 13 nursing homes were included as intervention work-sites. Five of these had external consultants in the intervention process, while the remaining eight used the consultants of the OHS. At the pharmaceutical company many departments that might have been ideal for participation in IPAW were not included because they participated in other projects, in some cases even in more than one project at the same time. The supervisors and shop stewards were afraid that IPAW would be confused with these other projects and also that the employees were becoming 'fed up with projects'. In the municipal technical services great resistance was experienced from some of the workers and shop stewards, who represented the

traditional values of the labour unions and the workers' collective. These workers saw the project as a possible way to increase productivity and reduce the labour force. Some of the work-sites where these sentiments were strong were not included in IPAW.

Thus, although the project committees and the local supervisors and shop stewards in principle could understand the ideal study design, other considerations were much more important to them. We had no way of changing this, even if we had wanted to. If we had tried to force the 'ideal design' through, it would have destroyed the project.

The shortcomings and problems mentioned here are not specific for the present study. Rather, these issues have to be faced by all researchers initiating psychosocial intervention projects at the work-sites. We find it important that obstacles and barriers as well as the ways to overcome them are included as legitimate research topics in the literature (Griffiths, 1999).

6.3. *The psychosocial scales of IPAW*

Another aspect of the study design is the use of questionnaire scales as measures of the important psychosocial variables shown in table 1. We wanted to use variables that were based on theoretical considerations, since the whole intervention model of IPAW is theory based. Results of the analyses presented in tables 2–5 seem to indicate that our scales have good reliability and validity. It is of special importance that each of the seven psychosocial work environment scales appears to measure distinct characteristics of the work environment, which is demonstrated by the relatively low intercorrelations (table 3) and by the differential pattern of associations with health end-points (table 5). For instance, skill discretion and decision authority are only moderately correlated ($r = .35$) and are quite differently associated with the health end-points.

With regard to the scales for health and psychological well-being the situation is quite different. In fact, three of the scales seem to measure much the same dimension: the scales for mental health, vitality and emotional stress. Factor analyses do not point at these three scales as measuring three distinct latent characteristics, and our results in tables 4–5 seem to support that there is a great overlap between these scales. As far as we can see, this overlap has no negative consequences for our analyses. The main problem seems to be that we may have bothered the respondents with too many questions on psychological well-being in the questionnaire. (In later studies at NIOH we have left the scale on emotional stress out but kept the two SF-36 scales). We did not want to merge or change these scales because it is important to be able to make comparisons with other national and international studies where the scales have been used.

The purpose of the present paper is purely descriptive and we do not interpret the associations between the work environment variables and the health end-points (table 5) as demonstrations of causal associations. Many authors have warned against the interpretation of 'trivial' associations in cross-sectional studies as indications of causality (Frese & Zapf, 1988; Kristensen, 1996). It is, however, interesting to study the *pattern* of associations displayed in table 5. In this connection it is worth noticing that the two 'new' work environment variables in IPAW (meaning of work and predictability) show stronger associations with the health end-points than most of the other variables. It will be very interesting to see if we find a similar pattern in the prospective analyses.

6.4. *The future analyses of IPAW*

In the future analyses of IPAW we will follow two different strategies of analysis. First, we will study the development of the pre-determined end-points (the measures of health and

psychological well-being, job satisfaction, absence from work, and labour turnover) in the intervention and control groups. These analyses will be according to the 'intention to treat' principle. Second, we will study whether the interventions actually had the intended impact on the psychosocial work environment. These analyses will be performed with the seven work environment variables in table 2 as end-points. Thus, we will distinguish between the questions of aetiology and intervention effectiveness (Skov & Kristensen, 1996). Among the intervention work-sites we will then investigate whether the magnitude of the changes of the psychosocial work environment factors were associated with changes in perceived health, psychological well-being, absence from work and turnover. According to our model, the level of absence from work reflects not only the health of the workers but also the quality of the (psychosocial) work environment, which means that absence rates should be a sensitive indicator of work environment improvements.

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Impact of the psychosocial work environment on registered absence from work: A two-year longitudinal study using the IPAW cohort

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Keywords: *Decision authority; Predictability; Psychosocial work environment; Sickness absence; Prospective study.*

During the Intervention Project on Absence and Well-being (IPAW), a 5-year project conducted in Denmark, we investigated psychosocial work environment factors as independent predictors of the number of absence days per year. The present two-year longitudinal study used the IPAW cohort, but was not intended to study intervention effects, which will be reported later. Data were derived from baseline questionnaires and employers' registers of absence for 1919 participants (1305 women, 614 men, mainly in low-skilled jobs) in different occupations from 52 workplaces. These workplaces included municipal care, municipal technical services and a large pharmaceutical company. Analyses were performed by Poisson regression accounting for over-dispersion. After controlling for age, family type, health behaviours and physical work environment variables, we found that high levels of decision authority predicted low absence rates in both women and men. We tested two new psychosocial constructs developed for this study: Predictability (relating to being informed on future events at work) and Meaning of Work (relating to how meaningful and useful the work is perceived to be). Higher Predictability was a significant predictor of lower absence rates in men. This study adds to the body of evidence that the psychosocial working environment influences absence and should therefore be considered to be an important target for intervention.

1. Introduction

Absence from work due to sickness has considerable negative effects for employees and employers as well as society. Sickness absence has been shown to be a strong predictor of disability pensioning (Brun, Bøggild, & Eshøj, 2003; Lund, 2001), as well as morbidity and mortality (Kivimäki *et al*., 2003b; Marmot, Feeney, Shipley, North, & Syme, 1995).

Absence rates exhibit a strong association with self-rated health and other measures of health, but health does not explain all the variation in absence (Kivimäki *et al*., 1997;

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Voss, Floderus, & Diderichsen, 2001). It has been proposed that absence can also be considered as a way for employees to cope with the demands and burdens they meet at work and otherwise (Kristensen, 1991). Recent findings indicate that although mortality is highest in employees with high absence, mortality is lower with a small amount of short absence spells than with no absence (Kivimäki *et al*., 2003b).

Working environment can affect the rate of absence both via health and through other pathways. Even though a major part of the effect of work environment on absence is expected to be mediated by changes in health due to exposures in the working environment, one would also expect that workers who experience an unsatisfactory work environment will have more absence than others even when controlling for measures of health such as physician-diagnosed diseases, self-rated health, symptoms or functional ability. In the search for explanations of variations in absence rates between workplaces, the focus is increasingly directed towards stress and the factors in work that could cause stress—the psychosocial work environment. Work stress is known to increase the risk of a wide range of health effects (Bongers, de Winter, Kompier, & Hildebrandt, 1993; Steenland *et al*., 2000; Tennant, 2001), and a poor psychosocial work environment could also affect absence via decreased motivation and a coping behaviour of avoiding the workplace.

The existing research on the associations between psychosocial factors in the working environment and absence from work has been criticized for several reasons (Kivimäki *et al*., 1997; North *et al*., 1993). Many studies have been published, but most of them are cross-sectional and based on self-reported absence data, lack objective or external measures of work environment exposures, and fail to control for relevant confounders such as health behaviours and demographics. Studies are often restricted to male populations, although women have higher rates of absence and there might be gender differences in the causes of absence.

However, a limited number of prospective studies exist that utilize employer-registered absence data, control for relevant confounders and include both genders (Kivimäki, Elovainio, Vahtera, & Ferrie, 2003a; Kivimäki *et al*., 1997; Melchior, Niedhammer, Berkman, & Goldberg, 2003; Niedhammer, Bugel, Goldberg, Leclerc, & Guéguen, 1998; North *et al*., 1993; North, Syme, Feeney, Shipley, & Marmot, 1996). These studies are predominantly based on the demand-control-support model (Karasek & Theorell, 1990), and have consistently found that a high level of decision authority is related to a low level of absence. Skill discretion, the other variable in the job control/decision latitude concept, was tested in three studies and two found significant associations. Four of the six studies showed a significant association between a high score on some measure of social support and low rates of absence, although in two of these studies, this was only found in men. No consistent associations with psychological demands at work were found; in some studies high demands predicted high absence, in other studies it predicted low absence—particularly in men.

In addition to the demand-control-support model, other theoretical approaches have been proposed, to investigate the contribution of psychosocial workplace conditions to absence. Research on the effort-reward imbalance model (ERI), for example, has found that a mismatch between high efforts and low rewards at work increases the risk for cardiovascular disease and psychiatric disorders (Siegrist, 1996; Siegrist *et al*., 2004; Stansfeld, Fuhrer, Shipley, & Marmot, 1999; Steenland *et al*., 2000). With regard to sickness absence, a cross-sectional study with 189 male middle managers in Germany found that indicators of low reward (status incongruence, status discrepancy and forced job change) significantly increased the risk of absence (Peter & Siegrist, 1997). The job characteristics model (JCM) has also been proposed to predict absence and attendance, but the authors admit: 'this notion awaits systematic research testing' (Hackman & Oldham, 1980, p. 94).

We have only been able to find two later attempts to test the model: A study in Spanish (Zurriaga, Ramos, Gonzalez-Roma, Espejo, & Zornoza, 2000) that according to the English abstract found that some characteristics predicted satisfaction and commitment, but not absence. A Dutch study (Landeweerd & Boumans, 1994) in which the JCM components 'work pressure' and 'promotion/growth' explain 2–4% of the variance in self-reported 'Absence frequency' in a non-defined period before answering the questionnaire on job characteristics. Although the ERI and JCM models are theoretically very interesting, they have not yet generated similar quantity and quality of empirical research as the demand-control-support model.

In research based on the demand-control-support model, some studies also found other psychosocial factors to be significant predictors of absence, including low job satisfaction (North *et al*., 1993), high job insecurity and downsizing (Kivimäki *et al*., 1997), and low organizational justice (Kivimäki *et al*., 2003a).

Various measures of personality and affectivity have also been studied as predictors of absence. Vahtera, Pentti, and Uutela (1996) found sense of coherence to have some impact on absence, and we have earlier found sense of coherence to be associated with stress symptoms in the Intervention Project on Absence and Well-being (IPAW) population (Albertsen, Nielsen, & Borg, 2001).

Although many factors have been studied, it is still possible that other factors than the ones mentioned could affect absence. On the basis of general stress theory (Frankenhaeuser, 1991; Johnson & Johansson, 1991; Karasek & Theorell, 1990; Levi, 1984; Sapolsky, 1994) we developed two new constructs that might be important: Meaning of work and Predictability (Nielsen, Kristensen, & Smith-Hansen, 2002). *Meaning of work* is present when the respondent finds the tasks meaningful and feels that the work is important and useful for others. *Predictability* refers to relevant and useful information on major coming events at the workplace, for example changes in organization, new technology, physical changes, etc. To our knowledge, no previous studies have investigated these two constructs as predictors of absence, but they do have notable similarities with the constructs *task significance* and *feedback* in the Job Characteristics Model (Hackman & Oldham, 1980). In general, most of the different models of psychosocial work environment are partly overlapping.

The purpose of this paper is to analyse the impact of psychosocial workplace factors on absence in the IPAW population, a Danish cohort of multiple occupations and worksites. Psychosocial work environment was measured by a broad approach, not only assessing demands, control and social support, but also including two new constructs, Predictability and Meaning of work, that were developed for the purpose of this study.

The analyses were adjusted for a wide range of potential confounders including several aspects of the physical work environment. Although it is well documented that physical work environment factors also predict absence (Blank & Diderichsen, 1995; Norlund, Pålsson, Ohlsson, & Skerfving, 2000), none of the studies mentioned above included both psychosocial and physical work environment factors.

2. Participants and methods

The data used in this paper were collected in the IPAW project, a controlled intervention study with 5 years of follow-up. However, it is not the intention of the present paper to report on the effects of interventions. This will be done at a later stage. A more detailed description on the rationale, design, study population and measurements of IPAW can be found elsewhere (Nielsen *et al*., 2002). The present paper analyses predictors and covariates

measured with the baseline questionnaire and absence data derived from the organizations' absence registries during a 2-year follow-up period.

2.1. *Respondents and workplaces*

IPAW contains 52 Danish workplaces with 2716 employees at baseline. Employees in temporary jobs are not included. At 22 of these workplaces, interventions were conducted to improve the psychosocial work environment and thereby to promote employees' well-being and reduce high absence rates. The remaining 30 workplaces are matched control groups with high ($n = 14$) and low absence ($n = 16$) before baseline, respectively. All 52 workplaces belong to three different organizations: (1) a major pharmaceutical company (production factories, packaging units, laboratories, canteens and cleaning departments); (2) municipal workplaces in the care sector (nursing homes for the elderly and institutions for the mentally handicapped), and (3) the technical services of the municipality (cemeteries, parks, workshops, sewage pumping stations, road construction and repair, administrative offices). The workplaces in (2) and (3) belong to the municipality of Copenhagen, and the departments of the pharmaceutical company are also placed in the vicinity of Copenhagen.

The baseline questionnaire was sent to the participants during the periods 5 May 1996 to 14 April 1997. Of the 2716 employees, 2052 completed the questionnaire, yielding a participation rate of 75.6%. For 1980 participants we have information from both questionnaires and absence registers, and data are linked via the Personal Registration Number issued to all Danes by the authorities. Only 53 participants were 60 years or older, reflecting the common use of early retirement in Denmark and we consequently excluded these highly selected respondents. We further excluded eight trainees and apprentices, yielding a final sample of 1919 participants. The distribution of respondents on gender, age, intervention assignment and the three organizations is shown in Table 1.

2.2. *Measurement of psychosocial work environment*

Psychosocial work place factors were measured by the Danish version (Netterstøm *et al*., 1988) of the Whitehall II scales (Marmot *et al*., 1991) on (1) *Psychological demands*; (2) *Decision authority*; (3) S*kill discretion*; (4) S*ocial support from colleagues*; and (5) S*upervisor social support*. To this battery we added two new scales on (6) *Meaning of work* ('I feel that I make

Table 1. Distribution of participants by gender, age, organization and intervention assignment.

	Women	Men
	% (*n*)	% (*n*)
Age		
< 29	72 (230)	28 (88)
30–39	64 (388)	26 (219)
40–49	71 (396)	29 (164)
50–59	67 (287)	33 (141)
Organization		
Nursing homes	89 (825)	11 (102)
Pharmaceutical	61 (412)	39 (264)
Technical services	22 (68)	78 (248)
Intervention assignment		
Intervention	69 (762)	31 (343)
Control, high absence	66 (328)	34 (172)
Control, low absence	68 (215)	32 (99)
Total	**68 (1305)**	**32 (614)**

an important contribution at work', 'My work tasks are experienced as meaningful', 'I feel motivated and dedicated in my work', 'My work is very useful to the recipients') and (7) *Predictability of work* ('In my workplace we get information on, for example, important decisions, changes and future plans well in advance', 'I get all the information I need to do my work well'). These two scales have been developed and validated by our research group (Nielsen *et al*., 2002). The first five scales have four response categories ranging from 'often' to 'never', and the two new scales have five categories, ranging from 'fits precisely' to 'doesn't fit'. The scales are coded according to their names, i.e. high scores are unfavourable for psychological demands and favourable for the other variables.

Table 2 shows the characteristics of the scales. In general, the psychometric properties were satisfactory, although Cronbach's α was a little low for the demands scale that is based on only two items. The correlations between the scales were in the range .04–.44; highest between predictability and support from supervisor and lowest between psychological demands and meaning of work.

2.3. *Measurement of co-variates*

As co-variates, we measured physical work environment, health behaviours, socio-economic status (SES), family type, age, gender, and sense of coherence (SOC).

Physical work environment was measured by four questions on how much of the daily working time one is exposed to the following: twisting the back, lifting more than 30 kg, repeating the same job task many times per hour, tobacco smoke from others (six response categories from 'almost all the time' to 'never'); and one question on intensity of physical activity at work (five response categories from 'very light' to 'very heavy').

According to employment grade, education and job-title, the respondents were classified into five *social classes*: 1 = executive managers and/or academics; 2 = middle managers and/or 3–4 years of further education; 3 = other white-collar workers; 4 = skilled blue-collar workers; 5 = semi-skilled or unskilled workers.

Health behaviours were covered by questions on smoking, alcohol consumption, and height (in cm) and weight (in kg) from which we calculated body mass index (BMI). Regarding smoking, we asked the participants if they smoked daily, with the response categories: (1) Yes; (2) No, but I have been smoking; and (3) No, I have never smoked. Current smokers were further asked to state how many cigarettes, cheroots, cigars, or how many grams of pipe tobacco they smoked on a regular day, and based on this information we calculated consumption of tobacco per day. With regard to alcohol consumption we asked the respondents to state the average numbers of drinks per week during the last year.

Table 2. Characteristics of the psychosocial scales used in the IPAW baseline study.

Scale	Number of items	Cronbach's α	Inter-item correlations	Mean	SD	Percent missing (%)
Psychological demands	2	.56	.41	57.9	21.7	0.7
Decision authority	8	.81	.18–.56	66.7	20.6	0.5
Skill discretion	4	.69	.30–.47	75.8	18.4	0.5
Support from colleagues	2	.76	.61	76.7	23.8	1.0
Support from supervisors	2	.84	.72	68.9	27.6	0.8
Meaning of work	4	.78	.37–.59	76.6	16.3	1.0
Predictability	2	.75	.60	50.8	24.5	1.6

Respondents had the option to express this in number of: (1) bottles of beer (33 cl); (2) glasses of wine; or (3) 2 cl-amounts of strong liquor, and based on this information we calculated the number of units of alcohol per week.

The *family type* variable is based on a question on the total number of children in the home, and one on the number of children below 7 years. It was coded into one of the following values: 1 = single without children; 2 = couple without children; 3 = couple with children who are all aged 7 years or older; 4 = couple with children below 7 years (including those with older siblings); 5 = single parent. Family type is included in the analyses as a categorical variable.

Sense of coherence was measured by a Danish translation of a Swedish 9-item scale (Setterlind & Larsson, 1995) developed on the basis of Antonovsky's work. Owing to the psychometric properties, the original 3 subscales were merged into one scale with a Cronbach's α of .77 (Albertsen *et al*., 2001).

2.4. *Measurement of absence*

Absence data were drawn from the computer-based registers of the workplaces. For every absence period, we received data on the first and last day and a code of the type of absence. Consecutive or overlapping periods were collapsed. We did not have access to the actual work-schedules, but calculated five workdays per seven calendar days. We analysed absence due to the employees' own sickness, including work injuries and occupational diseases, but not absence due to other reasons, such as a child's first sick-day or pregnancy-related absence, vacation or maternity leave.

The time of answering was distributed over approximately one year, hence individual absence data were defined by the answering date plus 24 months. This was chosen instead of calendar years, first, to secure truly prospective analyses and, second, to avoid unnecessary waiting time between baseline and follow-up. The fixed duration of follow-up rules out seasonal variation. For 75 persons who did not fill in the answering date in the questionnaire, a date was inserted corresponding to the time when their colleagues answered.

For each employee the total number of absence days in the 24-months' period was calculated and divided by two to express the mean absence per year. Three hundred employees had left their jobs during follow-up. To account for this in the analyses, the logarithm of the actual observation time was included as an off-set variable, that is, a regression variable with a constant coefficient of 1 for each observation (McCullagh & Nelder, 1989).

2.5. *Data analysis*

Analyses were made on individual data with psychosocial factors in the working environment as predictors of absence days, adjusted for potential confounders. Analyses were performed separately by gender, because of the general finding of gender differences in the associations. Absence days are counting data that are not following the normal distribution, and fit better with the Poisson distribution. Poisson regression has been found to be superior to linear regression in predicting absence (Smulders & Nijhuis, 1999). Multiple Poisson regression was employed in the SAS package, using the GENMOD procedure. As in previous studies (Niedhammer *et al*., 1998; North *et al*., 1993), a Poisson regression model with a scale parameter was used to specify an over-dispersed model. This means that standard errors (s.e.) are adjusted according to the over-dispersion. Furthermore,

the covariates were standardized to a mean of zero and a variance of 1. The regression parameters can be interpreted as the relative change in number of absence days (i.e. the rate ratio, RR) when moving 1 SD on the dimension of the independent variable. Note that confidence intervals for rate ratios are not symmetrical, owing to logarithmic transformation.

In the analyses, two categorical variables are used: intervention assignment (either intervention, control high absence, or control low absence) and organization (pharmaceutical company, municipal care, and technical services). They are forced into the regression models to control for differences in unmeasured variables.

The associations between psychosocial work environment and absence were estimated in the following steps: in the first model, we calculated associations for each psychosocial scale controlling for age, family type, health behaviours, organization and intervention assignment. In the second model, we added physical work environment variables as single items. The third model repeated the analyses from the second model, but now psychosocial factors were also adjusted for each other. In the final step, we eliminated psychosocial factors from the model if $p > .10$. For evaluation of statistical significance, we kept to the conventional limit of $p < .05$.

We refrained from adjusting for socio-economic status (SES) in the analyses, because we assumed that the 'effect' of SES is to a certain extent mediated by differences in variables that are included in the analyses. Therefore, adjusting for SES would be over-controlling. However, as this assumption can be debated, we recalculated the final model with adjustment for SES, to allow for comparison.

3. Results

Overall, the mean number of absence days per year was 12.7 (95% CI: 11.7–13.8) for women and 11.8 (95% CI: 10.5–13.1) for men.

The associations of each of the psychosocial work environment scales with absence days per year were stratified by gender and adjusted for age, family type, smoking, alcohol, BMI, organization and intervention assignment of the workplace in a multiple Poisson regression (Table 3, model 1). In both genders, high levels of decision authority, predictability, support from the supervisor and skill discretion significantly predicted decreased numbers of absence days. In women, but not men, support from colleagues and meaning of work were also predictive of low absence rates.

In model 2, the results are further adjusted for the five physical work environment items. This weakens the associations to some degree and, consequently, only three variables remain significant: decision authority in both genders and predictability and supervisor support in men.

In the next step, all the variables are included in one common model, adjusting all the psychosocial factors for each other as well as for the covariates from Table 3. The results are shown in Table 4. Decision authority and predictability remain significant, with only slightly lower rate ratios. The rate ratio for support from the supervisor, however, decreased substantially and the variable was no longer significant. The rate ratio describes the change in absence when moving 1 SD on the relevant dimension. For example, the mean absence of women was 12.7 days, and the absence of a woman with 1 SD above mean score of decision authority and mean score of all other covariates could be calculated as the mean multiplied by the rate ratio: $12.7 \times 0.81 = 10.3$ days.

Table 3. Multiple Poisson regression of each psychosocial factor on absence days per year.

	Women				Men			
	Model 1		Model 2		Model 1		Model 2	
	RR	CI	RR	CI	RR	CI	RR	CI
Psychological demands	1.09	0.99–1.20	1.04	0.94–1.15	0.95	0.84–1.08	0.96	0.85–1.09
Skill discretion	**0.88**	**0.81–0.97**	0.93	0.84–1.03	**0.87**	**0.78–0.98**	0.91	0.80–1.03
Decision authority	**0.75**	**0.68–0.82**	**0.80**	**0.72–0.89**	**0.72**	**0.64–0.81**	**0.79**	**0.69–0.90**
Support from supervisor	**0.88**	**0.80–0.96**	0.92	0.83–1.01	**0.80**	**0.71–0.90**	**0.81**	**0.71–0.91**
Support from colleagues	**0.91**	**0.83–0.99**	0.93	0.85–1.02	0.93	0.82–1.05	0.89	0.79–1.01
Predictability	**0.88**	**0.80–0.96**	0.93	0.84–1.02	**0.74**	**0.66–0.84**	**0.79**	**0.69–0.89**
Meaning of work	**0.90**	**0.82–0.99**	0.94	0.85–1.04	0.97	0.86–1.10	0.95	0.84–1.08

Rate ratios (RR) for moving 1 standard deviation on the independent variables, and confidence intervals (CI). Bold type indicates significant results ($p < .05$).
Model 1: Adjusted for age, family type, smoking, alcohol, BMI, organization, and intervention assignment.
Model 2: Further adjusted for five physical work environment factors (twisting the back, lifting more than 30 kg, repeating tasks many times per hour, tobacco smoke from others, physical activity).

Finally, the least significant psychosocial work environment factors are removed until all p-values are below .10. All the other covariates stay in the model regardless of their significance level (Table 5, model 1). As a result, the impact of decision authority becomes less pronounced, but remains significant in both genders. Predictability is virtually unaffected. In women, skill discretion now becomes marginally significant, but in the opposite of the expected direction: Women with higher skill discretion showed higher absence rates. In men, high psychological demands approached significance for lower absence rates, which is also in the opposite of the expected direction.

As described in the method section, we re-calculated the final analysis adjusted for SES for comparison. Both decision authority and predictability (in men) remained significant predictors of absence in this model (Table 5, model 2). However, some interesting differences between the genders can be observed. In women, the rate ratio for decision authority was weakened from 0.87 to 0.91, whereas in men, the rate ratio is strengthened from 0.86 to 0.81, when SES is introduced in the model. SES itself is not an independent predictor of absence among men in this model, but for women, low SES is a significant predictor of high absence rates. The associations with skill discretion in women and predictability in men show only slight changes. It is also notable that when controlling for

Table 4.

	Women		Men	
	RR	CI	RR	CI
Psychological demands	1.01	0.91–1.13	0.89	0.78–1.03
Skill discretion	0.98	0.87–1.09	1.00	0.86–1.17
Decision authority	**0.81**	**0.72–0.92**	**0.84**	**0.72–0.96**
Support from supervisor	0.98	0.87–1.11	0.89	0.77–1.04
Support from colleagues	0.98	0.88–1.08	0.96	0.84–1.10
Predictability	1.01	0.90–1.15	**0.82**	**0.70–0.95**
Meaning of work	1.00	0.89–1.13	1.10	0.95–1.27

Rate ratios (RR) for moving 1 standard deviation on the independent variables, and confidence intervals (CI). Bold type indicates significant results ($p < .05$).
Adjusted for age, family type, physical work environment factors, smoking, alcohol, BMI, intervention assignment and organization.

Table 5. Multiple Poisson regression. In model 1, the least significant psychosocial factors are eliminated until all p-values are below .10.

	Women				Men			
	Model 1		Model 2		Model 1		Model 2	
	RR	CI	RR	CI	RR	CI	RR	CI
Psychological demands	–	–	–	–	0.89	0.79–1.01	0.90	0.80–1.03
Skill discretion	**1.08**	**1.01–1.16**	**1.09**	**1.01–1.18**	–	–	–	–
Decision authority	**0.87**	**0.81–0.94**	**0.91**	**0.84–0.98**	**0.86**	**0.75–0.98**	**0.81**	**0.71–0.93**
Predictability	–	–	–	–	**0.81**	**0.71–0.92**	**0.81**	**0.71–0.92**
Socio-economic status	–	–	**1.14**	**1.05–1.25**	–	–	0.93	0.81–1.06

Rate ratios (RR) for moving 1 standard deviation on the independent variables, and confidence intervals (CI). Bold type indicates significant results ($p < .05$).
Model 1: Controlled for age, family type, physical work environment factors, smoking, alcohol, BMI, intervention assignment and organization.
Model 2: Further controlled for socio-economic status.

SES, the difference in intercept between men and women was substantially reduced (results not shown).

When we further added sense of coherence as a measure of personality to the final model, it did not reach significance, and the rate ratios of the other variables remained virtually unchanged (± 0.02 or less, results not shown).

When we restricted the analyses to the 543 female and 271 male respondents from the control workplaces, the effects remained substantially the same (results not shown). The largest change of rate ratio was 0.15. Confidence intervals became much wider due to the smaller sample, but in all cases contained the original estimate from the full data analysis.

4. Discussion

We found that psychosocial work environment factors acted as independent predictors of absence from work. Decision authority was a significant predictor of absence in both genders. Our new scale on predictability showed a strong and highly significant association with absence in men. This was true even when controlling for the other psychosocial work environment factors and for several physical work environment variables that have not been included in previous prospective studies. Adjusting for SES, which might be considered over-controlling, did not change the results substantially either. It is possible that high decision authority at work decreases stress and thereby illness and also provides more room for coping with the challenges at work, thus reducing the need for absence as a coping strategy. Although predictability does not provide the power to change coming events, it gives the individual the possibility to prepare and a sense of control that might reduce the impact of stressful events.

As mentioned in the introduction, demands, social support and skill discretion were found in some of the previous studies to be a predictor of absence but in this study neither demands, supervisor support nor support from colleagues was significant after controlling for the physical and the other psychosocial work environment factors. Skill discretion was only supported as a predictor in some of the previous studies, and in this study it even ended up predicting higher absence in women, when including all psychosocial workplace factors in the model. When baseline results were presented at workplaces, we sometimes had the

response from low skill groups that what we were presenting as 'skill discretion' was perceived by them more like 'demands for change', sometimes exceeding their resources and resembling negative experiences from previous learning situations. As most participants in this cohort did not have high levels of education, this perception might have contributed to the observed association. Similarly, Hackman and Oldham (1980, p. 93) hypothesized that 'changes in jobs that increase internal motivation (i.e. 'enriched' jobs with higher skill discretion; our note) might simultaneously prompt decreased absenteeism for more competent employees and increased absenteeism for their less competent co-workers'.

Together with other research (de Jonge, Reuvers, Houtman, & Kompier, 2000) this study strongly suggests that it will be more useful to analyse the constructs skill discretion and decision authority separately than to combine them in the construct job control/decision latitude.

As both psychosocial and physical work environment factors have an unequal social distribution, they may be correlated, and controlling for physical work environment may tend towards over-control. In the present analyses, we included repetitive tasks as a physical work environment variable, but it is often also considered to be an important psychosocial variable. This may partly explain why the association between psychosocial variables and absence is weaker in this study than in studies that did not control for physical work environment.

Adjusting the result for SES caused only modest changes of the rate ratios. Only in women did SES act as a predictor of absence when analysed together with the other covariates. In men, the rate ratio was slightly below 1 and far from significance. This might indicate that the variables included in the analyses control most of the large social differences in absence rates in men. As stated by others (Niedhammer *et al*., 1998; North *et al*., 1996) the true associations are probably in the range between the adjusted and the unadjusted estimates. This finding also suggests that the difference between the genders is partly caused by the difference in social position of working men and women. An interesting question is what other factors than work environment and health behaviours are needed to explain the social differences in absence among women? Better measures of demands in family life might contribute further, but there may also be other factors, such as pregnancy and life events.

The IPAW project has some strong features contributing to the credibility of the results. The cohort includes a large number of workers of both genders and different types of job in both private and public sectors. Many variables of interest are measured and analysed, including psychosocial and physical work environment, health behaviours and demographic variables. The measures are theory-based, well validated, and most of them are comparable to previous results from other studies (Nielsen *et al*., 2002). The study is prospective, which rules out reverse causality, and is based on registered absence data that rules out recall bias. Furthermore, we contribute to knowledge by empirically testing two new constructs of theoretical interest. Absence data are not just drawn by calendar years, but for a period defined relative to the date of the individuals answering the questionnaire. Effects of seasonal variation in absence are excluded because the period of the study covered two full years.

There are also some limitations to this study. Possible changes in work environment during the follow-up are not analysed, and would tend to underestimate the associations. The majority of the workers in the cohort were in the lower social strata, where work environment problems are most prevalent and contribute most to absence. This also means that associations may be stronger than in studies with participants in higher social strata, and

that the weight of predictors might be different in different job-groups. The majority of the study population are women and, geographically, the study is restricted to the Copenhagen area. In that sense, the generalizability is limited.

In general, the findings of a study will depend on its context. For example, Verhaeghe, Mak, Van Maele, Kornitzer, and De Backer (2003), found an effect of social support in healthcare workers, but not in controls from other service jobs. This might also explain why different studies do not produce identical results.

Absence is obviously caused by a multitude of different factors. Although many variables are included, many others of potential interest are not. Unfortunately, we do not have measures of management styles, which may affect the psychosocial work environment, or absence norms that may affect absence behaviour. Nor did we ask for life events that could also be important causes for absence.

We recommend that future studies on psychosocial work environment and absence should consider including the new construct, Predictability, as well as other variables that have shown interesting results in research published after we designed our questionnaire for the IPAW project in 1996. These include job insecurity, downsizing (Kivimäki *et al*., 1997), and organizational justice (Kivimäki *et al*., 2003a) as well as physical work environment factors. Also it would be very interesting to test the Effort-Reward-Imbalance model and other models in good prospective studies.

Employees are not always ill when they are absent, but the reverse is also true: they are not always absent when they are ill. Presenteeism, that is, going to work when ill, represents consequences of health problems that are not measured by absence figures. Unfortunately, we only included questions on this in a questionnaire that was used at a later stage of the IPAW project.

In this study we chose to focus on the number of absence days as an outcome measure, as it is easy to understand and of great importance to the economy of both workplaces and society. The impact of work environment and other factors may vary with different lengths of absence spells, and this could influence the comparability of results. When 'number of days' is the outcome measure, long spells count much more, and when 'number of spells' is the outcome, numerous short spells contribute more.

The results of the present study add to the evidence that a poor psychosocial working environment influence absence. This also suggests that interventions to improve psychosocial workplace factors might be able to lower absence rates, but further research is needed. Data collection on the interventions in IPAW has been completed, and we will later be able to analyse if and how the interventions in this cohort have affected sickness absence.

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Psychosocial Work Environment and Registered Absence From Work: Estimating the Etiologic Fraction

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Background *Evidence is growing that an adverse psychosocial work environment increases sickness absence, but little is known on the magnitude of this problem or the impact of specific factors.*
Methods *Psychological demands, decision authority, skill discretion, social support from colleagues or supervisor, predictability, and meaning of work were assessed with questionnaires at baseline and sickness absence was followed-up in employers' registers for 1,919 respondents (response rate 75.2%, 68% women, mainly low-skilled jobs) from 52 Danish workplaces during a 2-year period. Etiologic fractions (EFs) were calculated with the most favorable quartiles as reference.*
Results *In the fully adjusted model, the following EFs were found: decision authority: 12%; social support from supervisors: 8%; psychological demands: 6%; and predictability: 5%. In total, the seven psychosocial factors explained 29% of all sick-leave days.*
Conclusions *The results suggest that improving the psychosocial work environment among the less favorable 75% may prevent substantial amounts of absence.* Am. J. Ind. Med. 49:187–196, 2006. © *2006 Wiley-Liss, Inc.*

KEY WORDS: decision authority; social support; psychological demands; predictability; absenteeism; attributable fraction; population attributable risk; prospective study; physical work environment; health behavior

INTRODUCTION

In the international literature on absence from work it is often implicitly understood that all absence can be prevented, which indicates that the optimal level of absence is zero. This is an unrealistic and potentially harmful assumption. Even in organizations with perfect working conditions there will be sickness absence due to the normal diseases of the working population. This level of absence should not be seen as a problem, but as a natural phenomenon of any workplace. The viewpoint of the present article is that a fraction of the absence days may be prevented by improving the working conditions of the workers. This fraction represents absence among workers exposed to stressors and other exposures at work that ought to be eliminated or reduced.

To effectively prevent this ''unnatural'' absence and its consequences, we need to know not only the factors statistically associated with absence, but also the size of their relative contribution. This is important in order to prioritize possible preventive measures. The relative contribution of a predictor to an outcome can be determined by

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calculating the etiologic fraction (EFs), which is defined as the fraction of the outcome that was caused by the predictor in question [Miettinen, 1974].

Etiologic fractions have been used by the World Health Organization (WHO) on a global scale to estimate the burden of disease produced by different preventable causes throughout the regions of the world [Rodgers et al., 2002; Ezzati et al., 2003]. In the area of work environment, EFs have been calculated—among other things—to assess the proportion of heart disease caused by working environment factors [Olsen and Kristensen, 1991], to estimate the cost of occupational injuries and illnesses [Leigh et al., 2000], and to calculate the proportion of fatalities related to occupational factors [Nurminen and Karjalainen, 2001]. Most recently, a special issue of this journal was devoted to report several estimates of the global and regional burden of occupational diseases and injuries from the WHO comparative risk assessment (CRA), including lung cancer, leukemia, malignant mesothelioma, asthma, chronic obstructive pulmonary disease, pneumoconiosis, low back pain, contaminated sharps injuries in health care workers, noise-induced hearing loss, and occupational injuries [Eijkemans and Takala, 2005].

With regard to psychosocial work environment and sickness absence, the Belstress study has reported population attributable fractions of 8.3%–26.7% for job control in different strata of male workers [Moreau et al., 2003]. In absolute figures, this corresponds to 0.5–3.8 days of absence per worker per year. Recently, the French GAZEL study has presented an analysis of fractions attributable to stress-related and physical work factors [Melchior et al., 2005]. They found work factors to explain about 20% of all absence, particularly in manual workers and clerks, thereby explaining part of the social gradient in sickness absence. Physical factors explained a larger proportion of musculoskeletal disorders, and psychosocial factors had the largest impact on psychiatric disorders, but also some impact on musculoskeletal diagnoses.

Most other studies have not reported similar measures, but in a few cases it is possible to calculate EFs from the reported figures and they are generally within the same magnitude. When calculated in the same way as in the present article, an earlier article from the GAZEL-study showed that 17%–22% of the absence in men were explained by decision latitude and social support, and in women 13% of short absences were explained by psychological demands [Melchior et al., 2003]. The Finnish 10-town study showed that worktime control, job control, and job demands explained 15% of the medically certified absence periods of more than 3 days in men and 33% in women [Ala-Mursula et al., 2002]. In the British Whitehall II study, decision authority, skill discretion, job demands, and social support at work explained 11%–30% of short absence spells (1–7 days), and 6%–15% of long spells in both genders [Stansfeld et al., 1999].

A Danish report presented the EFs of work environment factors for self-reported absence in a large representative sample of the Danish working population and in a population of computer-users [Jensen et al., 2002]. In both samples different combinations of physical and psychosocial work environment factors explained more than one third of the absence.

One can summarize that, although there is an increasing interest in the relative contribution of psychosocial factors to sickness absence, only very few studies analyzed EFs or provided enough information for readers to calculate them by themselves. The knowledge in this field has to be considered still as sparse and provisional and more research is needed.

We studied the impact of the psychosocial work environment on sickness absence in the Intervention Project on Absence and Well-being (IPAW) [Nielsen et al., 2004]. We found that high levels of decision authority predicted low numbers of sickness absence days in both women and men after 2 years of follow-up. In men, high predictability at work was also associated with low sickness absence. Other factors, such as psychological demands or social support at work did not show statistically significant effects in the final model [Nielsen et al., 2002].

The focus of the present study is to reanalyze the IPAW dataset with regard to the relative contribution of the psychosocial variables to sickness absence days. A central research question in this respect is, if psychosocial exposure variables need to be brought to the presumed optimum (e.g., to increase decision authority to the highest level possible) to significantly reduce sickness absence or if already moderate improvements might produce positive effects. This question is especially important with regard to workplace interventions, which often will have to settle for less than optimal improvements of the work environment. Therefore, we analyzed differences between sickness absence rates across quartiles of exposures and calculated the contribution of both the single psychosocial variables (individual EF) and the common contribution of all psychosocial variables (overall EF).

The analyses are based on company-recorded sickness absence data, and feature two improvements compared to previous studies on psychosocial work environment and sickness absence. We adjusted the analyses for several potential confounders, including a wider range of physical work environment exposures, and we conceptualized and tested two new psychosocial factors: meaning and predictability at work.

STUDY POPULATION AND METHODS

The data analyzed in this report were collected in IPAW—a controlled intervention study with 5 years of follow-up [Nielsen et al., 2002]. The present study does not report on intervention effects, as they will be analyzed at a

later stage. Predictors and covariates were measured by the baseline questionnaire and the absence data were derived from the organizations' absence registries during a 2-year follow-up period.

Respondents and Worksites

IPAW includes 52 Danish worksites with 2,730 employees at baseline (excluding temporary contracts). At 22 of these worksites, interventions were conducted to improve the psychosocial work environment and thereby promote employees' well-being and reduce absence rates. The remaining 30 worksites were matched control groups with high ($n = 14$) and low absence ($n = 16$) at baseline, respectively. All 52 worksites belonged to three organizations: (1) a major pharmaceutical company (production factories, packaging units, laboratories, canteens, and cleaning departments; 13 workplaces, 731 respondents); (2) municipal workplaces in the care sector (15 nursing homes for the elderly and 7 institutions for mentally handicapped; 994 respondents); and (3) the technical services of the municipality (cemeteries, parks, workshops, sewage pumping stations, road construction and repair, administrative offices; 17 workplaces, 343 respondents). The workplaces in (2) and (3) belonged to the municipality of Copenhagen, and the Departments of the Pharmaceutical Company were also placed in the Copenhagen area.

The baseline questionnaire was sent to the participants between May 1996 and April 1997. Of the 2,730 employees, 2,053 completed the questionnaire, yielding a participation rate of 75.2%. We have information from absence registers for 1980 of the respondents. Only 53 respondents were 60 years or older, reflecting the common use of early retirement in Denmark. We consequently excluded these highly selected subjects. We further excluded eight trainees and apprentices, yielding a final sample of 1,919 subjects. The mean age was 40 years and 68% of the participants were women. The level of education and social status was generally low, 63% of the respondents were skilled, semi-skilled, or unskilled workers.

Measurement of Predictors and Co-variates

The questions in the scales on psychological demands, decision authority, and skill discretion, were derived from the Whitehall II study [Marmot et al., 1991] and translated into Danish [Netterstrøm et al., 1998], whereas questions on support from colleagues and supervisor were developed in a previous study [Netterstrøm et al., 1998]. These five scales consist of two to eight items, each with four response categories ranging from ''often'' to ''never.'' In addition, scales on meaning of work and predictability were developed and validated by our research group [Nielsen et al., 2002]. Meaning of work is present when the respondent finds the tasks meaningful, and feels that the work is important and useful for others. Predictability refers to relevant and useful information on major upcoming events at the workplace, for example, changes in organization, new technology, etc. The two scales have four items on meaning and two on predictability, each item with five response categories ranging from ''fits precisely'' to ''doesn't fit.'' All seven scales were coded according to their names, that is, high scores are unfavorable for psychological demands and favorable for the other variables. Cronbach's alphas for the scales were generally satisfactory (0.69–0.84), except for the two-item scale on psychological demands, which had an alpha of 0.56 [Nielsen et al., 2002].

Exposures in the physical work environment were measured by single questions on how much of the daily working time one is exposed to the following: twisting the back, stooping work position, lifting more than 30 kg, pushing/pulling heavy burdens, repeating the same job task many times per hour, loud noise, temperature fluctuations, cold, dust, and tobacco smoke from others. For each of those exposures, we asked the respondents how often they occurred, with six response categories ranging from ''almost all the time'' to ''never.'' We further asked them to rate the intensity of physical activity at work on a five-point scale ranging from ''very light'' to ''very heavy.''

The classification of socioeconomic status (SES) was based on questions about employment grade, education and job-title. For 1,796 of the 1,919 people we had sufficient data to code SES. As the study includes few participants in the higher SES groups and further stratification reduces power, we chose to classify the respondents into only two groups: Low SES (skilled, semi-, or un-skilled workers) with 1,126 participants (63%) and high SES (White-collar workers etc.) with 670 participants (37%).

Health behaviors were measured by questions on smoking, alcohol consumption, and by calculating body mass index (BMI) from self-reported height and weight.

We asked the participants if they lived with a partner or alone, for the total number of children living at home, and how many of these were below the age of 7 years. Based on this, we created the variable ''family status'' with the following categories: 1, single without children; 2, couple without children; 3, couple with children that are all 7 years or older; 4, couple with children below 7 years (including those with older siblings); 5, single parent.

Measurement of Absence

Absence data were drawn from the computer-based registers of the workplaces. For this study, we used data recorded during the 24 months after the completion of the questionnaire. For 75 persons who did not fill in the date of completion in the questionnaire, we inserted a date in the middle of the period, in which their colleagues had responded.

For every absence period, we received data on first and last day and a code of the type of absence. We collapsed consecutive or overlapping periods. We calculated absence due to the employees' own sickness, including work injuries and occupational diseases and excluded absence due to other reasons, such as a child's first sick-day or pregnancy-related absence, vacation, or maternity leave. These reasons for being absent were reported by the employees when contacting the workplace about taking sick leave. In Denmark, employers are not allowed to have information on the health conditions of their employees, and we as researchers did not have access to any reports or diagnoses from physicians.

Data Analysis

Analyses were made on individual data adjusted for potential confounders. We divided each of the seven psychosocial scales into quartiles and calculated crude and adjusted rate ratios (RRs) based on multiple Poisson regression with scale parameters to specify an over-dispersed model. This means that standard errors (SE) were adjusted according to the over-dispersion. Three hundred employees had left their jobs during follow-up. To account for this in the analyses, the logarithm of the actual observation time was included as an off-set variable, that is, a regression variable with a constant coefficient of one for each observation [McCullagh and Nelder, 1989].

Adjusted RRs were calculated in four models. Model I was adjusted for age, gender, family status, type of organization and assignment to intervention or control group. Model II was adjusted for the variables in Model I plus health behaviors. Model III was further adjusted for physical workplace exposures.

We also ran a fourth model, which included SES. This model might be an over-adjustment, because SES was mainly based on occupational status that is likely to act as a proxy measure for some psychosocial exposures. A priori, we decided that Model III would be the most appropriate model, but that for the matter of completeness, we would include also the results after adjustment for SES (Model IV).

Intervention assignment and organization were forced into the models to control for possible differences in unmeasured variables such as organizational culture, effects of intervention workplace selection that was not fully addressed by the matching of control workplaces, or changes at the intervention workplaces during follow-up, which might have influenced sickness absence. In addition, we repeated analyses for control workplaces only.

Intervention assignment, organization, and family status were treated as categorical variables.

Based on RRs, we calculated the EF of the psychosocial work environment scales for each of the four models.

The data have zero to 64 missing values for each variable, with the exception of SES, which had 123 missing. This reduces the effective sample size to 1,820 in Model I, 1,720 in Model II and 1,556 in Model III. When adjusting for SES, the sample is 1,457.

When calculating EF, we used the quartile with the most favorable psychosocial exposure as the reference group (low score for demands, high score for other variables). Based on the actual distributions of the scores, the size of the reference group for different variables could not always be 25%, but varies from 20.3% to 36.2%. The EF expresses the excess of absence in the three most unfavorable quartiles of exposure, or, in other words, how many percent of absence days that would not have occurred, if exposure for all employees had been at the level of the most favorable quartile.

Figure 1 illustrates the principle of the calculation by the example of Model I for decision authority [Miettinen, 1974; Olsen and Kristensen, 1991]. The width of the columns in the histogram corresponds to the proportion of participants in the group, and the height reflects the RR. The area of the column represents the amount of absence in the group, and the shaded area above the line parallel to the top of column 1 represent the absence that would not have occurred if all four groups had the absence rates of the group with the lowest exposure. The EF is calculated by dividing this area by the total area of the four columns.

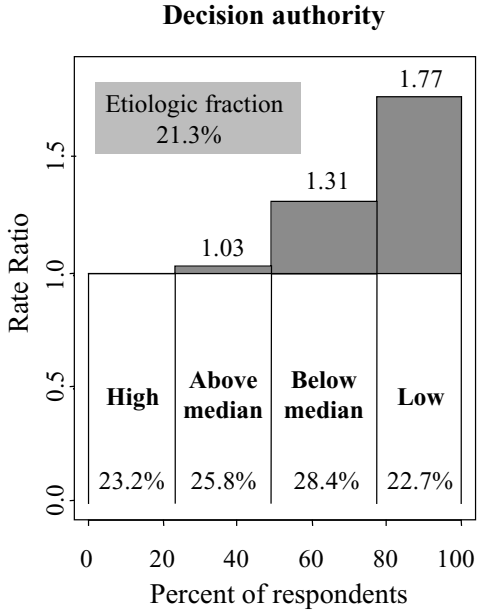

FIGURE 1. Example for calculation of etiologic fraction. Rate ratios of absence days in four quartiles of decision authority. The shaded area represents the surplus absence compared to the most favorable quartile with high decision authority, which is considered the reference group. The percentage of the respondents in each quartile is given in each column. The surplus absence (shaded area) is:

$$(0.03 \times 0.258) + (0.31 \times 0.284) + (0.77 \times 0.227) = 0.271$$

and the EF (shaded area in percent of total area) is:

$$0.271/(0.271 + 1) = 0.213 = 21.3\%.$$

After the calculation of the EF for each factor, we calculated the overall EF for the seven psychosocial factors by the sum-formula:

$$EF_{(total)} = 1 - \left(1-EF_{(a)}\right)\left(1-EF_{(b)}\right) \ldots \left(1-EF_{(n)}\right) \text{ [Miettinen, 1974].}$$

The use of the sum-formula rests on two theoretical conditions: that there are no interactions between the effects of predictors on the outcome, and that predictors are not statistically correlated. For the present study, we will test interaction effects between the workplace conditions by adding interaction terms in the Poisson regression model. We have previously reported that the psychosocial work environment variables in IPAW are only moderately correlated with each other (0.04–0.44) [Nielsen et al., 2002]. To assess how much this can affect the result, we will calculate combined EFs in cases where correlations range between 1 and −1. Using the sum formula under these conditions can be illustrated by the example in Figure 2.

Consider the case of two dichotomous risk factors A and B. Denote the number of people exposed to neither factor, A but not B, B but not A, and both factors by N_{00}, N_{A0}, N_{0B}, and N_{AB} respectively, and let the RRs be denoted by RR_{A0}, RR_{0B}, and RR_{AB} respectively.

The situation with a correlation of 0 is illustrated in Figure 2. A positive correlation in the population would make the shaded area smaller and increase the combined EF, whereas a negative correlation would make the shaded area larger and decrease the combined EF.

For the example in the figure, $RR_A = RR_B = 2.0$ and no correlation between A and B, the combined EF is 55.6%, and increasing or decreasing the correlation between 1 and −1 lead to EFs ranging between 50.0% and 60.0%. For $RR_A = RR_B = 1.3$ and no correlation, the combined EF is 27.3%, and changing the correlation lead to EFs ranging between 23.1% and 31.0%.

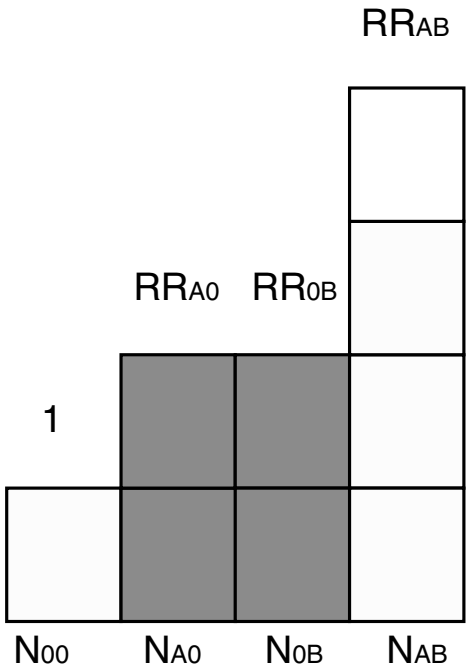

FIGURE 2. Illustration of the underlying assumptions when using the sum formula. In the figure, 50% are exposed to the risk factor A, and 50% to the risk factor B. As A and B are uncorrelated, there are 25% exposed to none of the factors (N_{00}), 25% exposed to only A (N_{A0}), 25% to only B (N_{0B}), and 25% to both (N_{AB}). As the RRs $RR_A = RR_B = 2$, then $RR_{AB} = 4$. The 4 units of area below the line RR = 1 equals the amount of absence if no surplus absence was caused by the risk factors A and B. The 5 units of area above this line represent the surplus absence, and thus the EF is $5/(4+5) = 55.6\%$. A positive correlation between A an B would increase the proportion of those exposed to both or none of the factors. This would increase the width of N_{AB} with a high RR and reduce the width of the shaded area with a lower RR, and thus increase the combined EF. If the correlation is 1, nobody will be exposed to only one of the factors. The area above RR = 1 is then 6, and EF is $6/(4+6) = 60\%$. A negative correlation would make the shaded area larger and decrease the combined EF. If the correlation is −1, half the population is exposed to A and the other half to B. The area above RR = 1 is then 4, and the EF is $4/(4+4) = 50\%$.

RESULTS

Overall, the mean number of absence days per year was 12.7 (95% CI: 11.7–13.8) for women and 11.8 (95% CI: 10.5–13.1) for men.

Table I shows the impact of the seven psychosocial workplace factors on sickness absence days, expressed in RRs and 95% confidence intervals (CI) after adjustment for age, gender, family status, organization, and intervention assignment. The last column shows *P*-values based on tests for trend. Low levels of decision authority, skill discretion, support from supervisors, and predictability were significantly associated with more sickness absence days. Psychological demands, with the CI of every quartile including the value 1, also showed a significant test for trend, whereas support from colleagues and meaning of work did not.

Figure 3 shows histograms for the psychosocial factors when adjusted for the covariates in Model I. Decision authority had by far the strongest association with absence followed by supervisor support, predictability, and skill discretion. However, there were different patterns. Decision authority and to a certain extent psychological demands showed a linear increase in RRs with increasing adverse exposure, whereas predictability and meaning of work showed elevated RRs only in the fourth (most adverse) quartile. Skill discretion and supervisor support had raised RR's already in the second quartile, with none or only small further increases in the third and fourth quartile. Support from colleagues had a more J-shaped association, with the second quartile having the lowest RR and only the fourth quartile being slightly above 1.

TABLE I. Exposure to Psychosocial Workplace Factors and Rate Ratios for Number of Sickness Absence Days per Year; 52 Danish Workplaces

	N	Absence days per year		
	(Total 1919)	Rate ratio	(95% CI)	*P* Test for trend
Psychosocial workplace exposure				
Decision authority				
High (reference)	443	1.00	—	
Above mean	492	1.03	(0.83, 1.28)	
Below mean	542	1.31	(1.07, 1.61)	
Low	433	1.77	(1.44, 2.18)	<.0001
Skill discretion				
High (reference)	543	1.00	—	
Above mean	397	1.19	(0.97, 1.46)	
Below mean	565	1.16	(0.96, 1.40)	
Low	404	1.23	(1.00, 1.50)	0.028
Psychological demands				
Low (reference)	449	1.00	—	
Below mean	491	1.05	(0.86, 1.29)	
Above mean	513	1.12	(0.92, 1.38)	
High	452	1.14	(0.92, 1.41)	0.046
Support from colleagues				
High (reference)	694	1.00	—	
Above mean	411	0.84	(0.69, 1.03)	
Below mean	447	0.97	(0.80, 1.16)	
Low	349	1.10	(0.90, 1.34)	0.41
Support from supervisor				
High (reference)	539	1.00	—	
Above mean	318	1.19	(0.96, 1.49)	
Below mean	707	1.17	(0.98, 1.41)	
Low	340	1.35	(1.09, 1.67)	0.0012
Meaning of work				
High (reference)	390	1.00	—	
Above mean	498	0.99	(0.80, 1.22)	
Below mean	594	1.01	(0.82, 1.24)	
Low	417	1.17	(0.93, 1.44)	0.20
Predictability				
High (reference)	466	1.00	—	
Above mean	307	1.00	(0.80, 1.27)	
Below mean	672	1.06	(0.88, 1.28)	
Low	445	1.31	(1.07, 1.60)	0.0051

Rate ratios calculated by Poisson regression adjusted for age, gender, family status, organization, and intervention assignment. Time under observation is included in the regression model as an offset variable to estimate absence days for respondents with incomplete follow-up time.

No significant interaction effects between the psychosocial factors occurred.

Table II shows EFs for each of the seven scales, and the sum for all scales. Model I gives estimates adjusted for sociodemographics, organization, and intervention assignment. When further adjusting for individual health behaviors in Model II, the estimates were only slightly reduced. When physical workplace exposures were added in Model III, the estimates became considerably smaller. The model gives a combined EF of 29%. Decision authority had the strongest impact on absence days (11.9%), followed by support from supervisors (8.3%), demands (6.0%), and predictability (5.2%). When we further adjusted for SES (Model IV), which might be considered over-adjustment, the total EF was

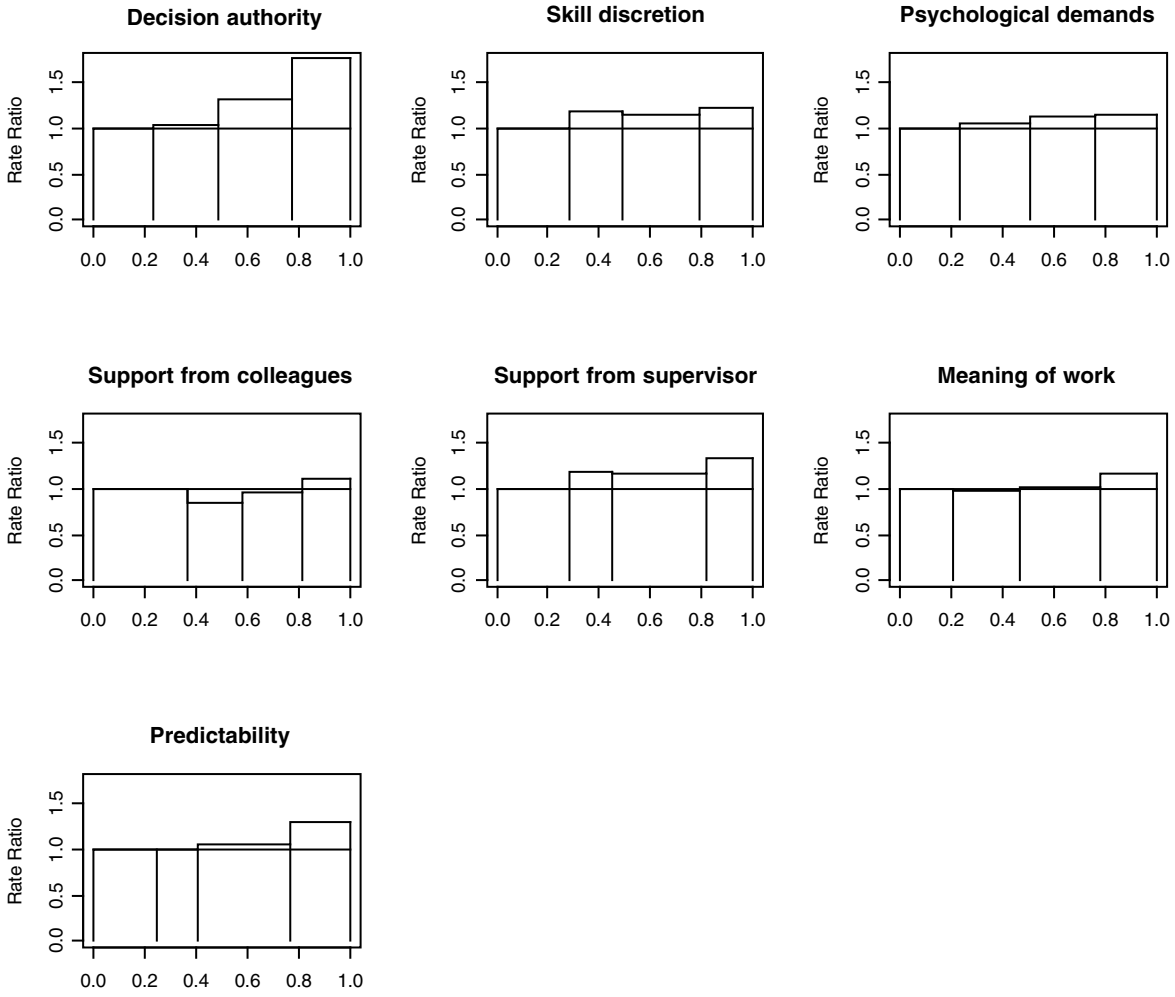

FIGURE 3. Histograms of the RRs for absence days by quartiles of the seven psychosocial work environment variables, adjusted for age, gender, family type, organization, and intervention assignment of the workplace; 52 Danish workplaces. The width of the columns in the histograms corresponds to the proportion of participants in the group, and the height reflects the Rate Ratio. The area above the line at RR = 1 reflect the proportion of absence caused by the factor.

reduced to 19%. Estimates of EFs of the main predictors changed only marginally (decision authority from 11.9% to 9.9%, supervisor support from 8.3% to 7.1%), whereas small and negative estimates became even smaller or more negative.

Repeating the analyses above with the 1,457 respondents with no missing data made no substantial changes in the results. Repeating Model III for participants from control workplaces only, produced similar results for most variables, however estimates increased for decision authority (20.5%) and support from colleagues (9.0%).

DISCUSSION

In this prospective study, the psychosocial work environment factors explained a considerable part of sickness absence days during 2 years of follow-up. When adjusting for demographic variables, health behavior, and physical work environment factors, the total EF was 29%.

As expected, employees of higher SES had a more favorable exposure profile, including higher decision authority. For this reason, it would be interesting to adjust the results for SES. However, the association between SES and absence is likely to be at least partly mediated by different psychosocial working conditions in the different socioeconomic groups and therefore including SES in the analyses could imply over-adjustment [North et al., 1996]. We therefore believe that the model without adjustment for SES is the most appropriate in our study. For the matter of completeness, however, we have also reported the EF when analyses were adjusted for SES, which resulted in a drop from 29% to 19%. Interestingly, the EF of the two strongest independent variables, decision

TABLE II. Fraction of Sickness Absence Attributable to each Psychosocial Workplace Exposure; 52 Danish Workplaces

Psychosocial workplace exposure	Model			
	I	II	III	IV
Decision authority	21.2%	22.6%	11.9%	9.9%
Skill discretion	11.8%	10.2%	2.6%	2.2%
Psychological demands	7.2%	8.1%	6.0%	6.1%
Support from colleagues	−2.4%	−1.7%	−1.6%	−3.4%
Support from supervisor	13.6%	12.6%	8.3%	7.1%
Meaning of work	3.5%	1.1%	−0.2%	−4.2%
Predictability	8.7%	6.6%	5.2%	2.4%
Total by sum-formula	**50%**	**48%**	**29%**	**19%**

Percentages indicate the proportion of absence days that would be reduced if absence levels of the participants would move from the level of the three least favorable exposure quartiles to the level of the most favorable exposure quartile.
Model I: Adjusted for age, gender, family status, organization, and intervention assignment.
Model II: Model I plus adjustment for smoking, alcohol consumption, and body mass index.
Model III: Model II plus adjustment for physical workplace exposures: stooping work position, twisting the back, lifting >30 kg, pushing/pulling heavy burdens, repetitive tasks, loud noise, temperature fluctuations, cold, dust, and heavy physical activity.
Model IV: Model III plus adjustment for socioeconomic status.

authority and supervisor support, were affected only marginally.

The single items on physical work environment exposures are not optimal measures, and therefore we did not calculate the EFs for these variables. However, the change of the EF estimate for the psychosocial factors from 48% to 29% when adjusting for these variables suggests that physical work environment also makes a considerable impact on the number of absence days.

IPAW has some strong features contributing to the validity of the results. The cohort includes a large number of workers of both genders and different types of jobs in both private and public sectors. Many variables of interest were measured and analyzed, including psychosocial and physical work environment, health behaviors, and demographic variables. These measures are theory based, well validated, and most of them are comparable to previous results from other studies [Nielsen et al., 2002]. Furthermore, we contribute by testing two new concepts of theoretical interest, meaning of work and predictability. Absence data are based on employers' registers. Because the data comprise two full years, seasonal variation could not have influenced the results.

There are also some limitations in our study. Possible changes in work environment during the follow-up, which would tend to underestimate the associations, were not assessed and could therefore not be analyzed. The majority of the workers were in lower social strata, where work environment problems are most prevalent and contribute most to absence. This means on the one hand that our study was conducted within a group, in which psychosocial exposures and absence is of high relevance. On the other hand, this means that the associations reported here might be stronger than in studies with participants in higher social strata, and that the weight of predictors might be different in different job-groups. Melchior et al. [2005] stated that they probably underestimated the level of absence and the impact of work factors, because their study cohort had a higher mean social status compared to the population at large. One needs also to consider that the majority of our study population are women, and geographically the study is restricted to the Copenhagen area. In that sense, the generalizability may be limited.

The use of the sum-formula rests on the two conditions that predictors are not statistically associated, and that they do not interact. We found no significant interaction effects between the independent variables, and we showed that the impact of even large changes in correlations is small. As the actual correlations for most exposure variables are small, we consider it acceptable to use the sum-formula to calculate total EFs. We included all seven variables in the calculation of the sum. If some of the EFs were chance findings, they should sum up to zero, and therefore should not distort the total sum. Therefore, we consider the calculated sum to be an acceptable measure of the total impact. We did not adjust the psychosocial factors for each other, because this would imply calculating the effect of a situation where one factor was changed while holding all other factors constant, an assumption, which is unrealistic in practical preventive efforts at the workplace.

When we repeated the analysis in Model III without individuals from intervention workplaces, the estimates of EF's for decision authority and support from colleagues increased. This may indicate that these factors were improved during intervention and the effects on absence thereby ameliorated. This would cause a weaker association at follow-up and thus an underestimation of the true impact.

The histograms in Figure 3 make it clearly visible that the risk of becoming absent is different for the different aspects of the psychosocial work environment. For predictability and meaning of work an increased risk of absence is only present in the least favorable fourth quartile, whereas for decision authority and demands risk of absence increases more or less linearly across the quartiles. For skill discretion and supervisor support risk of absence is higher in the three less favorable quartiles, but the RRs do not differ much between these three quartiles.

The findings indicate that the effect of preventive interventions might be expected to differ. With regard to predictability and meaning of work, interventions should be

directed toward increasing very low levels, that is, the least favorable fourth quartile to the level of the third quartile. One should not expect that a further improvement of meaning and predictability of work would result into more reduced absence. For skill discretion and supervisor support, on the other hand, it looks as if an effect on absence should only be expected if exposure is reduced to the level of the most favorable quartile. Improving decision authority and psychological demands would positively affect absence, without a visible threshold effect.

If one considers situations, where it is not feasible to reduce exposure to the level of the most favorable quartile, the effect of other strategies could be calculated from figures in Table II. For example, one could set the aim of improving quartile three and four to the median level, or to improve quartile four to the level of quartile three, quartile three to the level of quartile two etc.

The 29% EF of the psychosocial work environment factors in this study is within the range of the 6%–33% that was found in the Belstress, Gazel, Whitehall II, and 10-town studies [Stansfeld et al., 1999; Ala-Mursula et al., 2002; Melchior et al., 2003, 2005; Moreau et al., 2003]. We included seven psychosocial variables, and used the most favorable quartile as reference, whereas the other studies included between one and four psychosocial variables and some used the median or the most favorable tertile as reference. This will favor a higher EF in our study. On the other hand, we adjusted the analyses by a larger set of physical factors, which reduced the estimate considerably.

In a Danish report based on a representative national survey with self-reported absence, Jensen et al. [2002] have calculated that five physical and psychosocial work environment factors including job insecurity explain 38% of the absence days. The EF differed markedly by socio-economic strata, from 22% in managers and academics to 49% in unskilled workers. A social gradient was also found in the GAZEL study (without giving figures for the attributable fraction) [Melchior et al., 2005].

In the IPAW project, we have studied a cohort, where more than half of the women and three-quarters of the men are skilled, semiskilled, or unskilled workers. The results show that the potential for reducing absence is considerable in these groups. When we get to analyze the effects of interventions to improve psychosocial work environment in the IPAW workplaces, it will be very interesting to see if—and to what degree—this potential was realized.

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Psychosocial Work Environment Predictors of Short and Long Spells of Registered Sickness Absence During a 2-year Follow Up

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Objective: *The objective of this study was to investigate the impact of psychosocial work environment factors on short and long absence spells.* ***Methods:*** *Questionnaire data on work environment exposures and registered absence data during 2-year follow up were analyzed with Poisson regression for 1919 employees from the private and public sector.* ***Results:*** *Short spells (1–10 working days) were predicted by low supervisor support, low predictability, and low meaning at work among men and high skill discretion among women. Long spells (>10 days) were predicted by low decision authority, low supervisor support, and low predictability among men and high psychologic demands and low decision authority among women. The variables predictability and meaning at work were developed for this study.* ***Conclusion:*** *Specific psychosocial work environment factors have both common and different effects on short and long absence spells. Effects also differ by gender.* (J Occup Environ Med. *2006;48:591–598*)

During the last few decades, a large number of studies have reported associations between psychosocial working environment factors and absence from work. However, in a recent review, Allebeck and Mastekaasa found that only a limited number were of adequate quality.[1] Among the 20 acceptable studies on psychosocial factors, almost all studies used the demand–control–support model.[2,3] Control was almost equivocally found to be associated with lower absence, whereas the findings were inconsistent for demands and support. In those studies that separated job control in its two components decision authority and skill discretion, the former was a far more consistent predictor than the latter. Also, physical work environment factors were found to be associated with absence. The authors concluded that the evidence for an impact of psychosocial work environment factors on sickness absence is still limited and that more good research is needed.

It was further noted in the review that several researchers assume that longer absences are more associated with health problems than shorter absences and that therefore adverse and potential health-hazardous working conditions should better predict long than sport spells. The review comprised 10 studies that included different absence durations. In four of these studies, psychosocial work environment factors showed indeed a tendency to better predict long than

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short spells, whereas the six others observed no clear trend.

Similar results have been reported in other articles that were not mentioned in the review. Two articles from the Whitehall II study showed mixed results, in which job control in women and skill discretion in both genders were more strongly associated with longer spells, whereas demands and support were more associated with short spells.[4,5] The Finnish Raisio study found that lack of job control was a stronger predictor of certified absence spells of more than 3 days compared with shorter noncertified absences.[6] In the French GAZEL cohort, decision latitude and social support at work had very similar effects on short, intermediate, and long spells in men, but in women, decision latitude had strongest effect on intermediate spells (8–21 days), whereas demands affected short spells (1–7 days) more strongly.[7]

The purpose of the present study is to do a specific analysis on the impact of psychosocial work environment factors on the number of short- and long-term absence spells in a cohort of 1919 Danish employees followed up for 2 years. In previous papers based on the same cohort,[8–10] we have analyzed the impact of individual and workplace-level aggregated psychosocial work environment factors on the number of registered absence days. However, we have not previously studied the effect on absence spells or if the specific factors have different impacts on short and long absences.

A further aim of this study is to adjust the analyses not only for demographic variables and health behaviors, but also physical work environment factors that have not been included in most previous research on psychosocial factors and absence.

Study Population and Methods

This article is based on data from the Intervention Project on Absence and Well-being (IPAW)—a controlled intervention study.[8] The present paper does not report effects of intervention, which will be analyzed at a later stage. However, because interventions were intended to improve psychosocial work environment and thereby increase well-being and reduce absence, we compare analyses with and without adjustment for intervention assignment. Predictors and covariates were measured by the baseline questionnaire and the absence data were derived from the organizations' absence registries during a 2-year follow-up period.

Respondents and Worksites

IPAW includes 52 Danish worksites with 2730 employees at baseline (excluding temporary contracts). Of these, 22 were assigned for interventions to improve the psychosocial work environment and thereby promote employees' well-being and reduce absence rates. The remaining 30 worksites are controls matched on type of work for comparison and having either relatively high (n = 14) or low absence (n = 16) at baseline, respectively. The worksites belong to three organizations: 1) a major pharmaceutical company (production factories, packaging units, laboratories, canteens, and cleaning departments; 13 workplaces, 731 respondents), 2) municipal workplaces in the care sector (15 nursing homes for the elderly and seven institutions for mentally handicapped; 994 respondents), and 3) the technical services of the municipality (cemeteries, parks, workshops, sewage pumping stations, road construction and repair, administrative offices; 17 workplaces, 343 respondents). The workplaces are all located in the greater Copenhagen area.

The baseline questionnaire was sent to the participants between May 1996 and April 1997. Of the 2730 employees, 2053 completed the questionnaire, yielding a participation rate of 75.2%. We have information from absence registers for 1980 of the respondents. Only 53 respondents were 60 years or older, reflecting the common use of early retirement in Denmark. We consequently excluded these highly selected subjects. We further excluded eight trainees and apprentices, yielding a final sample of 1919 subjects. The mean age was 40 years and 68% of the participants were women. The level of education and social status was generally low; 63% of the respondents were skilled, semiskilled, or unskilled workers.

Measurement of Predictors and Covariates

The questions for the scales on psychologic demands, decision authority, and skill discretion were derived from the Whitehall II study[11] and translated into Danish in a previous study that also developed the questions on support from colleagues and supervisor.[12] These five scales consist of two to eight items, each with four response categories ranging from "often" to "never." In addition, scales on meaning of work and predictability were developed and validated by our research group.[8] *Meaning of work* is present when the respondent finds the tasks meaningful and feels that the work is important and useful for others. *Predictability* refers to relevant and useful information on major upcoming events at the workplace, eg, changes in organization, new technology, and so on. The two scales have four items on meaning and two on predictability, each item with five response categories ranging from "fits precisely" to "does not fit." All seven scales were coded according to their names, ie, high scores are unfavorable for psychologic demands and favorable for the other variables. Cronbach's alphas for the scales were generally satisfactory (0.69–0.84), except for the two-item scale on psychologic demands, which had an alpha of 0.56.[8]

Exposures in the physical work environment were measured by single questions on how much of the

daily working time one is exposed to the following: twisting the back, stooping work position, lifting more than 30 kg, pushing/pulling heavy burdens, repeating the same job task many times per hour, loud noise, temperature fluctuations, cold, and dust. For each exposure, we asked the respondents how often they occurred with six response categories ranging from "almost all the time" to "never." We further asked respondents to rate the intensity of physical activity at work on a five-point scale ranging from "very light" to "very heavy."

Socioeconomic status (SES) was defined based on questions about employment grade, education, and job title. For 1796 of the 1919 people, we had sufficient data to code SES. The respondents were classified into six groups (managers/academics, middle managers, other white collar, skilled blue collar workers, semiskilled, and unskilled workers).

Health behaviors were measured by questions on smoking, alcohol consumption, and by calculating body mass index (BMI) from self-reported height and weight.

We asked the participants if they lived with a partner or alone, for the total number of children living at home, and how many of these were below the age of 7 years. Based on this, we created the variable *"family status"* with the following categories: 1 = single without children, 2 = couple without children, 3 = couple with children who are all seven years or older, 4 = couple with children below 7 years (including those with older siblings), and 5 = single parent.

Measurement of Absence

Absence data were drawn from the computer-based registers of the workplaces. We used data recorded during the 24 months after the completion of the questionnaire.

For every absence period, we received data on first and last day and a code of the type of absence. We collapsed consecutive or overlapping periods. We calculated absence resulting from the employees' own sickness, including work injuries and occupational diseases and excluded absence resulting from other reasons such as a child's first sick day or pregnancy-related absence, vacation, or maternity leave.

Unfortunately, there is no general consensus on the limits between short and long absence spells in the literature. We defined short absences as those lasting 1 to 10 days and long absences as more than 10 days. This is meaningful in a Danish context because sick-leave benefits during spells of up to 2 weeks or 10 working days are paid entirely by employers. For longer spells, a considerable part of the employers' costs are reimbursed by tax-financed public health insurance with a fixed maximum amount. Most employers are obliged by collective agreements to pay the difference up to normal wages, especially in higher occupational groups.

Data Analyses

Analyses were made on individual data with psychosocial factors in the working environment as predictors of short and long absence spells adjusted for potential confounders. Analyses were performed separately by gender. Multiple Poisson regression was used in the SAS package using the GENMOD procedure. Like in previous studies,[4,13] a Poisson regression model with a scale parameter was used to specify an overdispersed model. This means that standard errors (SE) are adjusted according to the overdispersion. For 300 participants with less than 2 years of follow up, the logarithm of the actual observation time was included as an offset variable that is a regression variable with a constant coefficient of one for each observation.[14]

Covariates were standardized to a mean of zero and a variance of one. The regression parameters can then be interpreted as the relative change in number of absence spells (ie, the rate ratio [RR]) when moving one standard deviation on the dimension of the independent variable. Note that confidence intervals for rate ratios are not symmetric as a result of logarithmic transformation.

The associations between psychosocial work environment and absence spells were estimated in the following steps. In the first model, we calculated associations for each psychosocial scale adjusted for age, family type, health behaviors (alcohol, smoking, and BMI), organization, and intervention assignment. In the second model, we additionally adjusted for the 10 single items on physical work environment.

We did not include SES in the models, because we assumed that SES is not a confounder but a variable involved in the causal pathway. Because SES is mainly based on occupational status, and occupational status influences the likelihood of being exposed to psychosocial workplace factors, associations between SES and sickness absence spells might be mediated by different exposure to psychosocial working conditions. If this assumption is correct, adjusting analyses on associations between psychosocial factors and absence spells for SES would be overadjustment. However, because this assumption can be debated, we have recalculated the final model with adjustment for SES.

The following variables were treated as categorical variables: intervention assignment (intervention workplace, control workplace with high absence rates, control workplace with low absence), organization (pharmaceutical company, municipal care, and technical services), family status, smoking (never smoked, exsmoker, moderate smoker, heavy smoker: more than 15 cigarettes per day), and SES.

Results

The 1619 participants with complete follow-up data had 8829 short spells of sickness absence (1–10 working days) and 507 long spells (>10 days) during the 2-year obser-

TABLE 1
Mean Number of Short, Long, and Total Spells During 2 Year of Follow Up by Gender, Age, Family Type and Socioeconomic Status

		Mean Number of Spells (95% confidence intervals)		
	N	Short (1–10 d)	Long (>10 d)	Total
Gender				
Women	1083	5.66 (5.36–5.97)	0.34 (0.29–0.39)	6.00 (5.68–6.32)
Men	536	5.03 (4.68–5.38)	0.26 (0.21–0.31)	5.29 (4.93–5.65)
Age				
18–29	250	6.08 (5.45–6.71)	0.15 (0.09–0.20)	6.23 (5.59–6.87)
30–39	509	6.21 (5.79–6.63)	0.26 (0.20–0.32)	6.47 (6.03–6.91)
40–49	491	5.12 (4.72–5.53)	0.34 (0.27–0.41)	5.46 (5.03–5.89)
50–59	369	4.42 (3.94–4.90)	0.47 (0.36–0.57)	4.89 (4.37–5.41)
Family type*				
Single, no children	269	5.23 (4.59–5.86)	0.30 (0.21–0.40)	5.53 (4.87–6.20)
Couple, no children	555	5.30 (4.88–5.72)	0.34 (0.27–0.40)	5.63 (5.20–6.07)
Couple, only children >7 y	359	4.77 (4.35–5.18)	0.25 (0.17–0.32)	5.01 (4.57–5.46)
Couple, (also) children <7 y	304	6.38 (5.86–6.90)	0.30 (0.22–0.39)	6.68 (6.13–7.23)
Single parent	119	6.24 (5.39–7.10)	0.42 (0.27–0.57)	6.66 (5.77–7.56)
Socioeconomic status†				
Managers, academics	48	2.04 (1.34–2.74)	0.17 (0.04–0.29)	2.21 (1.47–2.94)
Middle managers	286	5.88 (5.26–6.50)	0.19 (0.13–0.25)	6.07 (5.43–6.70)
Other white collar	236	4.84 (4.24–5.45)	0.17 (0.11–0.23)	5.01 (4.38–5.64)
Skilled workers	107	5.45 (4.61–6.29)	0.37 (0.25–0.50)	5.82 (4.95–6.69)
Un-/semiskilled salaried staff	564	5.19 (4.85–5.54)	0.39 (0.32–0.45)	5.58 (5.21–5.94)
Un-/semiskilled workers	276	6.72 (6.06–7.38)	0.40 (0.28–0.53)	7.12 (6.42–7.82)

*Thirteen missing.
†One hundred two missing (as a result of insufficient answers to the questions defining the variables).

vation period. Short spells had a mean length of 2.85 days and long spells a mean of 29.7 days. Only 8.8% had no absence spells at all. The individual with most absences had 233 absence days during the 2 years of follow up.

Table 1 shows the distribution of absence spells by gender, age groups, family types, and SES during the 2 years of follow up.

Women had more absence spells than men, particularly longer spells. With increasing age, the number of short spells declined but the number of long spells increased. Couples with children under the age of 7 years had the highest number of short spells, whereas single parents had more long absence spells than the other family types. Cohabitating parents with children who are all 7 years of age or above had the lowest number of absence spells, both shorter and longer. Generally, people of higher SES had less spells than those of lower SES. Regarding short spells, top managers and academics had lower numbers than the other five groups. Regarding long spells, the three white collar groups had less spells than the skilled, semiskilled, and unskilled groups.

Table 2 shows the association between psychosocial work environment factors and the number of short absence spells of up to 10 days. In women, high decision authority and high predictability at work were prospectively associated with a low number of short absence spells when adjusted for sociodemographic factors, health-related behaviors, organization, and intervention assignment (model 1). Further adjustment for physical work environment factors (model 2) attenuated effect sizes somewhat, and decision authority and predictability were no longer statistically significant, although the effect for predictability remained suggestive ($P = 0.07$). In addition, skill discretion, which was not significant in model 1, became a significant predictor in model 2. The effect was opposite of the expected direction, ie, higher skill discretion was associated with more short spells of absence.

In men, high scores of decision authority, supervisor support, predictability, and meaning of work were significantly associated with lower numbers of short absence spells when adjusted for covariates in model 1. Further adjustment for physical work environment factors in model 2 resulted into slightly attenuated but still statistically significant effect estimates for supervisor support, predictability, and meaning of work. The effect of decision authority, however, became statistically insignificant.

Table 3 shows the association between psychosocial work environment factors and the number of absence spells longer than 10 days. In women, low psychologic demands and high decision authority predicted significantly lower numbers of long-term absence spells in both model 1 and model 2.

TABLE 2
Associations Between Psychosocial Work Environment Factors and Number of Short Absence Spells*

	Model 1			Model 2		
Short Spells (1–10 d)	**RR**	**CI**	***P***	**RR**	**CI**	***P***
Women						
Psychologic demands	1.01	0.97–1.07	0.58	0.99	0.94–1.05	0.77
Skill discretion	1.01	0.96–1.06	0.73	**1.07**	**1.01–1.13**	**0.02**
Decision authority	**0.92**	**0.88–0.97**	**0.00**	0.97	0.92–1.03	0.33
Support from supervisor	0.98	0.93–1.03	0.37	0.98	0.93–1.04	0.52
Support from colleagues	0.96	0.91–1.01	0.14	0.96	0.91–1.02	0.15
Predictability at work	**0.93**	**0.89–0.98**	**0.01**	0.95	0.90–1.00	0.07
Meaning at work	0.98	0.93–1.03	0.37	1.01	0.96–1.07	0.68
Men						
Psychologic demands	0.99	0.92–1.07	0.84	1.01	0.94–1.09	0.82
Skill discretion	0.94	0.88–1.00	0.06	0.97	0.90–1.05	0.45
Decision authority	**0.89**	**0.83–0.96**	**0.00**	0.94	0.87–1.02	0.15
Support from supervisor	**0.91**	**0.85–0.97**	**0.01**	**0.93**	**0.86–0.99**	**0.03**
Support from colleagues	1.02	0.95–1.09	0.55	1.03	0.96–1.10	0.43
Predictability at work	**0.91**	**0.84–0.97**	**0.01**	**0.91**	**0.84–0.98**	**0.02**
Meaning at work	**0.91**	**0.85–0.97**	**0.01**	**0.91**	**0.86–0.98**	**0.01**

Rate ratios were calculated for a one standard deviation increase in the exposure variable. Model 1 is adjusted for age, family type, alcohol consumption, smoking, body mass index, organization, and intervention assignment. Model 2 is further adjusted for 10 measures of physical work environment: twisting the back, stooping work position, lifting more than 30 kg, pushing/pulling heavy burdens, repeating the same job task many times per hour, loud noise, temperature fluctuations, cold, dust, and physical activity. Significant results printed in bold.

*Rate ratios (RRs), 95% confidence intervals (CIs), and *P* values.

TABLE 3
Associations Between Psychosocial Work Environment Factors and Number of Long Absence Spells*

	Model 1			Model 2		
Long Spells (>10 d)	**RR**	**CI**	***P***	**RR**	**CI**	***P***
Women						
Psychologic demands	**1.19**	**1.08–1.32**	**0.00**	**1.13**	**1.01–1.26**	**0.03**
Skill discretion	0.99	0.89–1.09	0.78	1.06	0.95–1.19	0.28
Decision authority	**0.77**	**0.70–0.84**	**0.00**	**0.83**	**0.74–0.93**	**0.00**
Support from supervisor	0.93	0.84–1.03	0.18	0.98	0.88–1.10	0.77
Support from colleagues	0.93	0.84–1.03	0.15	0.96	0.86–1.06	0.40
Predictability at work	0.94	0.85–1.04	0.21	1.00	0.90–1.12	0.98
Meaning at work	0.99	0.89–1.10	0.84	1.03	0.91–1.16	0.64
Men						
Psychologic demands	0.93	0.80–1.10	0.41	0.95	0.80–1.13	0.60
Skill discretion	0.91	0.78–1.05	0.18	1.01	0.86–1.19	0.91
Decision authority	**0.75**	**0.64–0.87**	**0.00**	**0.81**	**0.68–0.96**	**0.02**
Support from supervisor	**0.77**	**0.67–0.89**	**0.00**	**0.81**	**0.70–0.94**	**0.01**
Support from colleagues	0.97	0.85–1.12	0.70	0.99	0.85–1.14	0.85
Predictability at work	**0.75**	**0.64–0.87**	**0.00**	**0.81**	**0.68–0.95**	**0.01**
Meaning at work	0.93	0.81–1.08	0.35	1.00	0.87–1.17	0.95

Rate ratios were calculated for a one standard deviation increase in the exposure variable. Model 1 is adjusted for age, family type, alcohol consumption, smoking, body mass index, organization, and intervention assignment. Model 2 is further adjusted for 10 measures of physical work environment: twisting the back, stooping work position, lifting more than 30 kg, pushing/pulling heavy burdens, repeating the same job task many times per hour, loud noise, temperature fluctuations, cold, dust, and physical activity. Significant results printed in bold.

*Rate ratios (RRs), 95% confidence intervals (CIs), and *P* values.

In men, decision authority, supervisor support, and predictability significantly predicted fewer long absences in both models.

When we further adjusted the analyses for SES, we found that rate ratios for significant predictors from Table 2 and Table 3 changed by less than 4% with the exception of the association between decision authority and long absence spells in women, in which the effect estimate was attenuated by 11%, from RR = 0.83 (confidence interval [CI] = 0.74–0.93) to RR = 0.92 (CI = 0.82–1.04).

When we repeated the analyses without adjusting for intervention as-

signment and organization, changes were generally very small. The estimates for decision authority were strengthened in women both for short spells (RR = 0.76, CI = 0.68–0.85) and long spells (RR = 0.92, CI = 0.87–0.97) and for short spells in men (RR = 0.81, CI = 0.72–1.00). Although all other changes were marginal with differences in RR of 0.03 or less, skill discretion for short spells in women was not statistical significant in this model (RR = 1.05, CI = 0.99–1.11).

Discussion

This study has shown that specific psychosocial work environment factors have effects on short and long absence spells. Two of seven factors (support from supervisors and predictability in men) showed significant effects for both short and long spells. In addition, skill discretion in women predicted long spells and showed a similar (although not statistically significant) association of the same direction with short spells. In men, decision authority predicted short spells and showed a lower and statistically insignificant association of the same direction with long spells. It is possible that with more statistical power, both effect sizes could have been statistically significant. On the other hand, psychologic demands and decision authority in women were significantly associated with short spells and showed no considerable effect size for long spells, whereas in men, meaning of work was significantly associated with long spells without showing any associations with short spells. These findings underline that it is important not only to analyze number of absence days as an outcome, but also to study the association of the work environment with different durations of absence in both genders.

Results are especially interesting with regard to decision authority, the only psychosocial work environment factor that had been consistently found to be associated with sickness absence in the literature.[1] In our previous analyses with the IPAW cohort, we found a strong effect of low decision authority on number of sickness absence days in both men and women.[9] Moreover, when we analyzed psychosocial work environment factors not on the individual, but on the workplace level,[10] low decision authority again predicted sickness absence. In the present study, however, decision authority was only associated with long absence spells, but not with short spells, when analyses were adjusted for physical exposures.

Psychologic demands, the other central component of the demand–control–support model, were predictive only for long absence spells in women. The Whitehall II study[15] found that high demands were associated with high absence (as a result of back pain) in lower SES groups, but with low absence in higher SES groups. This may explain some of the inconsistent findings in relation to demands and absence. Because of the low proportion of men of high SES in this study, it was not very feasible to calculate analyses stratified by SES to replicate these findings here.

To our knowledge, this is the first time that the effects of decision authority and psychologic demands on sickness absence were both controlled for physical workload and stratified for absence of different duration in a prospective study. Blank and Diderichsen[16] conducted similar analyses, but their study was cross-sectional. Like in our study, Blank and Diderichsen found that high psychologic demands were associated with absence only in women (and more strongly with long than short spells) and that low job control was associated with long spells in both genders. In contrast to our study, low job control was also associated with short spells in men. Frost et al also studied work environment and absence spells while controlling for physical exposures in another cross-sectional study[17] but used only one aggregated measure of psychosocial work environment, which makes comparison difficult.

This study also indicates that it is important to differentiate social support at work in support from supervisors and support from colleagues. Although support from colleagues was unrelated to both short and long sickness absence spells in both genders, support from supervisors predicted both fewer short and long absence spells in men.

Like social support from supervisors, high predictability at work was significantly associated with fewer short and long spells in men. In women, there was a clear and significant association with short spells before we adjusted for physical workload. After adjustment, the association was no longer statistical significant but remained suggestive. The other newly conceptualized variable, meaning of work, was only predictive for fewer short spells and this effect was restricted to men.

It is possible that a small part of the absence has been classified incorrectly, eg, leave because of a child's sickness registered as the employee's own sickness or vice versa. We analyzed only absences registered as employees' own sickness. Nondifferential misclassification would probably cause a dilution of associations and an underestimation of the significance of true effects. The distinction used in other studies between self-certified short absences and longer medically certified absences is not meaningful in a Danish context. Medical certification is not compulsory at fixed terms and is only made if required by the employer (who actually has to pay for the certificate if they require it earlier than 3 sickness absence days) or by the health insurance (most often at 4 weeks). Policies are very different between employers, and it is not registered in the absence data we used whether a physician certified a specific absence.

Potentially improvements of psychosocial work environment in intervention workplaces may have

ameliorated the effect of psychosocial factors on absence during follow up. Although we adjusted the analyses for intervention assignment, such changes may have diluted the true associations and thus introduced a minor underestimation of the true effect. Adjusting for organization may also cause a minor underestimation, because some of the factors analyzed may be associated with the organizations. As reported, not adjusting for these two variables resulted in very small changes, mainly strengthening of the estimates for decision authority.

Repeating analyses while adjusting the results for SES caused very minor changes, and because this adjustment implies a risk of overadjustment, we consider the rate ratios from model 2 as the most appropriate adjusted results. The small changes when adjusting for SES suggest that the confounders we have included may actually explain major parts of the social gradient in absence.

An unexpected finding in this study was that women with high levels of skill discretion had more short absence spells compared with women with low skill discretion. We found the same unexpected result when we analyzed the effect of skill discretion on number of absence days.[9] In discussions with study participants, we noted that some of the unskilled female participants in the study perceived what we called "skill discretion" more like "demands for change" that they felt straining. Researchers studying implementation of empowerment strategies such as introducing "self-governing groups" have reported similar experiences, especially in low-skilled employees.[18]

In general, effect sizes of the psychosocial factors in this study were stronger for long sickness absence than for short absence. This is in agreement with the recent review by Allebeck and Mastekaasa[1] that found a similar tendency in four of 10 studies that had analyzed different lengths of spells. It has been argued that longer spells are more related to health[19] and shorter spells more to coping.[20] If this assumption were correct, then our findings would indicate that adverse psychosocial working conditions influence sickness absence primarily through an increased risk of ill health. This would further indicate that strategies to reduce longer sickness absences should focus more on changes of potential health-hazardous psychosocial work environment exposures and less on changes in coping styles and individual behavior.

With regard to preventive intervention activities, the results of this study suggest several options. Increasing decision authority, for example, could be the strategy of choice for reducing long-term sickness absence, because it was associated with this outcome in both men and women. However, based on our findings, a significant change in short spells should not be expected. Increasing supervisor support and predictability, on the other side, would reduce both long- and short-term spells; however, the effect would be limited to men. In general, an intervention strategy that focuses on factors that have been identified in research and also carefully maps the prevailing problems in the local physical and psychosocial work environment is recommended.[21]

Finally, we want to point out that the cutoff point we used for short- and long-term spells is based on a national context. As delineated in the "Methods" section, we used a cutoff point of 10 days because in Denmark, the employer pays the first 10 lost working days, whereas the following period beyond 10 days is partly reimbursed by tax-financed health insurance. Other studies have used different cutoff points based on administrative regulations in the specific countries or on other considerations. It would be very interesting if international standards for defining short- and long-term absence periods could be developed in the near future so that different studies could be more reliably compared with each other.

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Workplace Levels of Psychosocial Factors as Prospective Predictors of Registered Sickness Absence

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Objective: *We sought to investigate whether workplace levels of psychosocial work environment factors predict individual sickness absence.* ***Methods:*** *Data were collected in a prospective study in 52 Danish workplaces in three organizations: municipal care, technical services, and a pharmaceutical company. Psychosocial factors were aggregated as workplace means. We used multilevel Poisson regression models with psychosocial factors as predictors and individual level sickness absence from absence registries as outcome.* ***Results:*** *High workplace levels of decision authority predicted low sickness absence in the technical services (rate ratio = 0.66, 95% confidence interval = 0.51–0.86) and high workplace levels of skill discretion predicted low sickness absence in the pharmaceutical company (rate ratio = 0.74, 95% confidence interval = 0.62–0.88) after control for relevant confounders. Workplaces in municipal care did not differ with respect to the psychosocial factors.* ***Conclusions:*** *Psychosocial factors at the workplace level may be important predictors of sickness absence.* (J Occup Environ Med. *2005;47:933–940*)

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Absence from work because of sickness has considerable negative effects for employees, employers, and the society. Sickness absence is a strong predictor of disability pensioning,[1,2] as well as morbidity and mortality.[3,4]

Psychosocial work environment factors have been found to predict sickness absence after adjustment for relevant confounders in six prospective studies.[5–10] These studies are predominantly based on the demand–control–support model[11] and have consistently found that a high level of decision authority is related to a low level of absence. Skill discretion, the other variable in the job control/decision latitude concept, was tested in three articles and two found significant associations. Four of the six articles showed a significant association between a high score on some measure of social support and low rates of absence, although in two of these studies, this was only found in men. No consistent associations with psychological demands at work were found; in some studies high demands predicted high absence, in other studies it predicted low absence, particularly in men. Beyond the demand–control–support model, other psychosocial factors, such as low job satisfaction,[5] high job insecurity and downsizing,[7] and low organizational justice,[8] have been found to be significant predictors of absence.

Recently, our research group analyzed prospective data on individual psychosocial work environment de-

terminants of company-recorded sickness absence days during 24 months of follow-up from the Intervention Project on Absence and Well-being (IPAW).[12] After controlling for age, family type, health behaviors and physical work environment variables, high levels of decision authority predicted low absence rates in both genders and high predictability was a significant predictor of lower absence rates in men.

Because of the prospective nature of IPAW, the objective measurement of sickness absence and the inclusion of a wide range of potential confounders, we believe that the associations we found are relatively robust. However, our analyses have the same limitation as the other above-mentioned psychosocial studies on determinants of sickness absence: We assessed and analyzed psychosocial workplace factors on the individual level, that is, exposure to psychosocial workplace factors was determined for each individual on the basis of his or her responses to specific questions. Although this is the usual method to measure psychosocial exposure, not only in sickness absence research but in psychosocial work and health studies in general, one has to be aware that a person's response to a specific question on a psychosocial workplace factor is a function of both the objective presence of factor and of the subjective appraisal by the person.[13] If the subjective appraisal by the person is systematically associated with the study outcome—in our case sickness absence—the subjective appraisal would introduce a bias. For example, some individuals might have a relatively stable psychological disposition for a generally negative view of the world, including their work environment and their health. This negative view could lead to a more negative appraisal of the working conditions (for example, the perception of more psychological demands and less decision authority) and also to a more negative assessment of the individual's health, which consequently could lead to taking more days of sickness absence. In this case, the association between the psychosocial workplace factor and sickness absence is artificially increased by a psychological disposition of the individual.

One way to address this problem is to measure the psychosocial work environment by workplace observations. A few work and health studies have conducted this so far and have produced very interesting results.[6,14–17] However, this method is still under development to a certain extent and faces the major challenge of being relatively time-consuming and expensive.

An alternative approach, followed in this article, is to measure psychosocial exposure by questionnaire on the individual level and then aggregate them at the workplace level. The aggregated scores from the particular workplace are assigned to all individuals working at this workplace and used as workplace level predictors in multilevel Poisson regression analyses.

We used the data from the above-mentioned IPAW study, which includes 1919 participants working at 52 different workplaces. The aim of this work is to answer the following three questions: 1) How different are workplaces with respect to psychosocial factors? 2) Which psychosocial factors at the workplace level predict sickness absence? 3) How much of the differences in sickness absence between workplaces can be explained by psychosocial factors at the workplace level?

Study Participants and Methods

Analyses are based on data from baseline questionnaires and employers' registers of absence for 1919 participants (1305 women, 614 men, mainly in low-skilled jobs) from 52 workplaces in municipal care, municipal technical services, and a large pharmaceutical company in Denmark. The data used in this article were collected in the Intervention Project on Absence and Well-being, a controlled intervention study with 5 years of follow-up (intervention effects are not analyzed here). Predictors and covariates were measured by the baseline questionnaire and absence data were derived from the organizations' absence registries during a 2-year follow-up period. A more detailed description on the rationale, design, study population, and measurements is available elsewhere.[12,18]

Respondents and Worksites

IPAW include 52 worksites with 2730 employees, excluding temporary contracts. At 22 of these worksites, interventions were conducted to improve the psychosocial work environment and thereby promote employees' well-being and reduce absence rates. The remaining 30 worksites are matched control groups with high ($n = 14$) and low absence ($n = 16$) at baseline, respectively. (Intervention effects are not analyzed here). All 52 worksites belong to three organizations: 1) a major pharmaceutical company (production factories, packaging units, laboratories, canteens and cleaning departments; 13 workplaces, 731 respondents), 2) municipal workplaces in the care sector (15 nursing homes for the elderly and 7 institutions for mentally handicapped; 994 respondents), and 3) the technical services of the municipality (cemeteries, parks, workshops, sewage pumping stations, road construction and repair, administrative offices; 17 workplaces, 343 respondents). The workplaces in 2) and 3) belong to the municipality of Copenhagen, and the departments of the pharmaceutical company are also placed in the Copenhagen area.

The baseline questionnaire was sent to the participants between May 1996 and April 1997. Of the 2730 employees, 2053 completed the questionnaire, yielding a participation rate of 75.2%. We have information from absence registers for

1980 of the respondents. Only 53 respondents were 60 years or older, reflecting the common use of early retirement in Denmark. We consequently excluded these highly selected subjects. We further excluded eight trainees and apprentices, yielding a final sample of 1919 subjects. The mean age was 40 years and 68% of the participants were women. The level of education and social status was generally low, 63% of the respondents were skilled, semi-skilled or unskilled workers.

Measurement of Predictors and Covariates

The questions in the scales on psychological demands, decision authority, and skill discretion, were derived and translated into Danish[19] from the Whitehall II study[20] and questions on support from colleagues and supervisor were developed in a previous study.[19] These five scales consist of two to eight items, each with four response categories ranging from "often" to "never." In addition, scales on meaning of work and predictability were developed and validated by our research group.[12] *Meaning of work* is present when the respondent finds the tasks meaningful and feels that the work is important and useful for others. *Predictability* refers to relevant and useful information on major upcoming events at the workplace, eg, changes in organization, new technology etc. The two scales have four items on meaning and two on predictability, each item with five response categories ranging from "fits precisely" to "doesn't fit." The scores on all seven scales were transformed to a range from 0 to 100 and all scales were coded according to their labels, ie, high scores are unfavorable for psychological demands and favorable for the other variables. Cronbach's alphas for the scales were generally satisfactory (0.69 to 0.84), except for the two-item scale on psychological demands, which had an alpha of 0.56.[12]

We assessed personal background variables of the participants, by recording age, gender and family status. The variable family status includes information on cohabitation and number of children living at home, with the following categories: 1 = single without children, 2 = couple without children, 3 = couple with children that are all seven years or older, 4 = couple with children below seven years (including those with older siblings), 5 = single parent. Health behaviors were measured by questions on smoking, alcohol consumption, and by calculating body mass index (BMI) from self-reported height and weight.

Measurement of Absence

Absence data were drawn from the computer-based registers of the workplaces. For this study we used data recorded during the 24 months after the completion of the questionnaire. For 75 persons who did not fill in the date of completion in the questionnaire, a date in the middle of the period, in which their colleagues had responded, was inserted.

For every absence period, we received data on first and last day and a code of the type of absence. We collapsed consecutive or overlapping periods. We calculated absence that was a result of the employees own sickness, including work injuries and occupational diseases and excluded absence attributable to other reasons, such as a child's first sick-day or pregnancy-related absence, vacation or maternity leave. Absence on the individual level is the outcome of interest, but the logarithm of workplace mean absence rates are also used to illustrate the workplace level effects.

Data Analyses

All analyses were stratified by the three main organizations, participating in this study: Municipal care, technical services, and pharmaceutical company. In the first step, we determined how much of the variance in each of the seven psychosocial factors was explained by differences between workplaces. These analyses were conducted by calculating multiple correlation coefficients (R^2) both stratified by the three organizations and by all organizations combined. If 10% or more of the variance of a psychosocial factor was explained by workplace differences in any strata, the factor was retained for the next steps in the analyses. Factors not fulfilling this criterion were dropped from the analyses, because workplace level effects of such factors are unlikely to be disclosed.

In the second step, we plotted workplace-level psychosocial factors against the logarithm of workplace-level absence rates. We calculated regression coefficients for the different workplaces weighted by the number of subjects at each workplace and added the trend line to the plots. In the third step, we used a multi-level Poisson regression model:

$$\log(y_{ij}) = X_{ij1}\beta_1 + X_{ij2}\beta_2 + \cdots + X_{ijl}\beta_l + u_j$$

$$u_j = Z_{j1}\delta_1 + Z_{j2}\delta_2 + \cdots + Z_{jp}\delta_p + \varepsilon_j$$

to model the number y_{ij} of sickness absence days for individual i in workplace j. The effect of individual level covariates $X_{ij1}, X_{ij2}, \ldots, X_{ijl}$ (eg, gender and age) and of workplace level covariates $Z_{j1}, Z_{j2}, \ldots, Z_{jp}$ (eg, mean level of influence at workplace j) are studied and a random workplace effect $\boldsymbol{\varepsilon}_{j,}$ assumed to be normally distributed is added. The contribution of the 52 workplaces is thus included in the model as the parameters u_j, j = 1, . . ., 52 on which a linear structure is imposed.

This model takes the clustered structure of the data into account and can be used to quantify the between workplace variation, because the variance of the random workplace effect ε_j is estimated. We adjusted the multilevel Poisson regressions for two classes of confounders. In model 1, analyses were adjusted for

the background variables age, gender, family status, and intervention group assignment, in model 2, we further adjusted for the health behaviors smoking, alcohol consumption and BMI. All analyses were done using SAS V8.2 (SAS Institute, Cary, NC). The multilevel Poisson regression model was fitted using the GLIMMIX macro.[21]

Results

Table 1 shows, stratified for the three organizations, how much of the variance in the seven psychosocial workplace factors was explained by differences between the 52 workplaces. For four of the seven psychosocial factors, the workplaces explained a variance of 10% or more within at least one stratum: Skill discretion (14%), decision authority (12%), and predictability (19%) within the technical services and psychological demands (11%), skill discretion (15%), and predictability (10%) within the pharmaceutical company. Within municipal care no more than 7% of the variance of any psychosocial factors was explained by the workplaces. Support from supervisors, support from coworkers, and meaning of work were eliminated from the following analyses because no more than 7% of their variance was explained by workplaces in any strata.

Figure 1 shows the logarithm of age- and gender-adjusted workplace mean absence rates plotted against estimated workplace means (±1 standard error of mean) for psychological demands, skill discretion, decision authority, and predictability. As would have been expected from the results in Table 1, we found very little exposure contrast between the workplaces in municipal care. In the technical services and the pharmaceutical company, low workplace levels of skill discretion and decision authority were associated with high workplace levels of absence. The figure also shows that one workplace in the technical services differed systematically from the other workplaces in this organization. This outlier also had a large standard error of mean, reflecting a small sample size. This did not affect the estimation procedure because we used regression analysis weighted by the number of employees.

Table 2 shows in more detail the findings from the weighted linear regression analyses for the effect of workplace-level psychosocial factors on workplace sickness absence. Because of the small sample size of just 52 workplace means, these analyses have low statistical power. Effect estimates of ±0.18 or greater were found for low skill discretion in the technical services (−0.28) and the pharmaceutical company (−0.18) and for decision authority (−0.23 to −0.36) in all three organizations.

Table 3 shows the effects of workplace-level psychosocial factors on individual level sickness absence days in a multilevel Poisson regression model. In model 1, the rate ratios (RR) are adjusted for the individual level background variables age, gender, family status, and intervention group assignment and in model 2, RRs are adjusted for individual level background variables and for the individual health behavior factors smoking, alcohol consumption and BMI.

Higher workplace levels of decision authority predicted lower sickness absence for the 17 workplaces in the technical services. Results were similar for the other organizations, although only borderline significant. Workplace levels of skill discretion were associated strongly with absence for the 13 workplaces in the pharmaceutical company. Results were similar for the technical services, though only borderline significant. Workplace levels of psychological demands were not strongly associated with absence and trends appear to differ across organizations. Workplace levels of predictability showed no association to absence.

In the last step, we estimated to what extent variation in sickness absence days are explained by workplace-level psychosocial factors. The estimated between workplace variation based on model 1 (adjusted for individual level background variables), showed that skill discretion explains 30% and decision authority explains 36% of the variation in sickness absence between the 52 workplaces. Together workplace levels of skill discretion and decision authority explained 44% of the variation in sickness absence between the 52 workplaces. When we calculated explained variance based on model 2 (adjusted for individual level background variables and health behaviors), skill discretion explained 44% and decision authority explained 33% of the variation in sickness absence between the 52 workplaces. Together these factors explained 52% of the variation in sickness absence between the 52 workplaces.

TABLE 1
Fraction of Variance Explained (R^2) vy Workplace Differences for the Seven Psychosocial Factors

Psychosocial factor	Municipal care	Technical services	Pharmaceutical company	Total
Psychological demands	0.074	0.045	0.113	0.083
Skill discretion	0.046	0.141	0.147	0.111
Decision authority	0.023	0.123	0.076	0.152
Support from supervisor	0.032	0.064	0.060	0.074
Support from colleagues	0.049	0.030	0.042	0.071
Predictability	0.071	0.191	0.101	0.136
Meaning of work	0.021	0.040	0.073	0.074

Discussion

In this study we found that psychosocial work environment factors at the workplace level predicted sick-

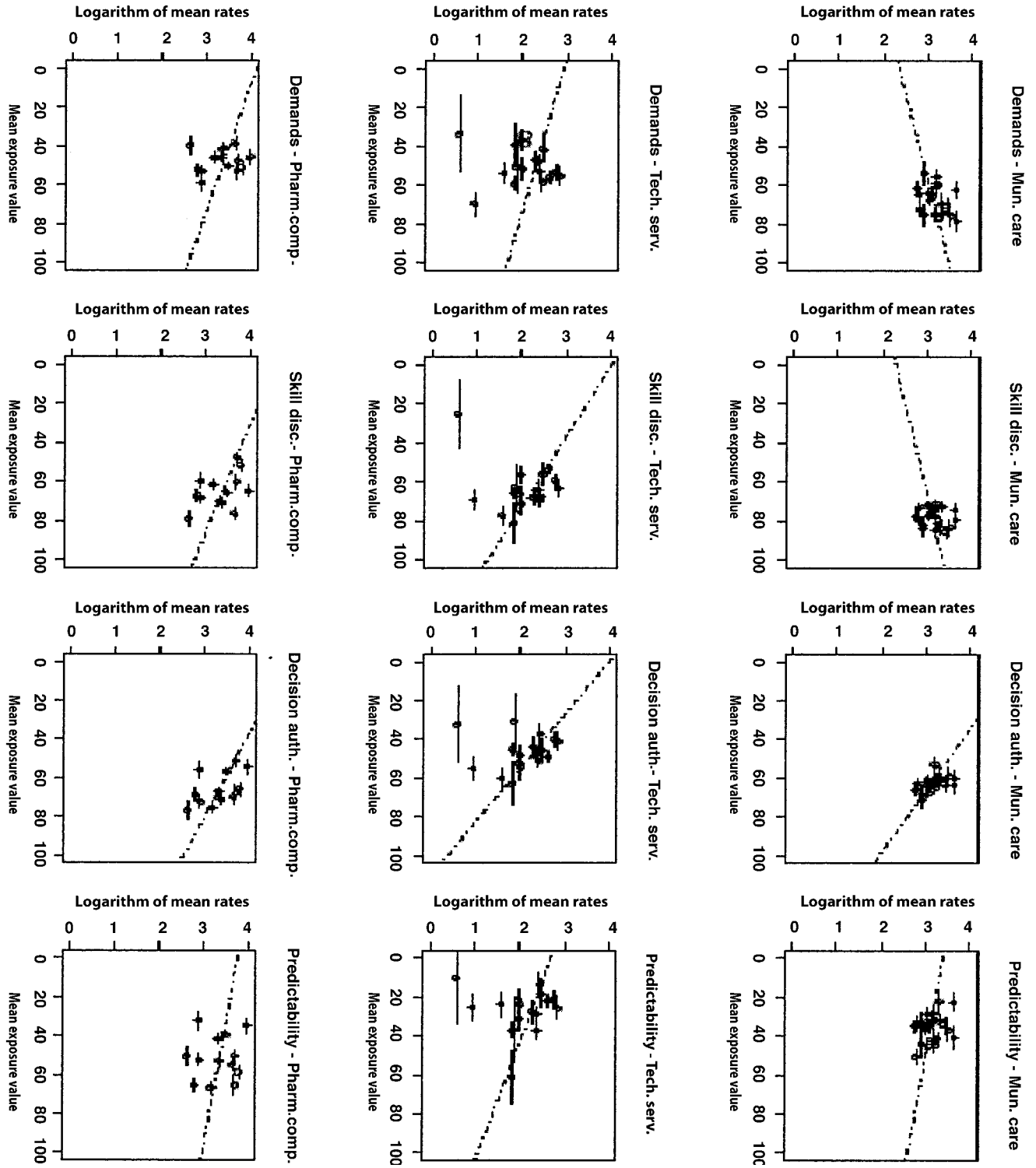

Fig. 1. Logarithm of the mean absence rates and workplace mean level (±1 standard error of mean) of demands, skill discretion, decision authority and predictability. All means are adjusted for gender and age. Regression coefficient from weighted linear regression analysis shown as dashed line.

ness absence after adjustments for age, gender, family status, intervention group assignment, smoking, alcohol consumption, and BMI. Previous prospective studies have found that individual level psychosocial work environment factors are important predictors for sickness absence: Low decision authority at the workplace seems to have the strongest and most consistent effect on sickness absence. Low social support at work

TABLE 2
Effect of Workplace Levels of Each of the Psychosocial Factors on the Logarithm of Workplace Absence Rates

Psychosocial factor	Organization	Estimate*	95% CI	*P* Value
Psychological demands	M	0.11	(−0.03, 0.26)	0.14
	T	−0.12	(−0.46, 0.21)	0.48
	P	−0.15	(−0.58, 0.27)	0.50
Skill discretion	M	0.11	(−0.13, 0.34)	0.39
	T	−0.28	(−0.56, 0.00)	0.07
	P	−0.18	(−0.43, 0.07)	0.18
Decision authority	M	−0.31	(−0.62, −0.01)	0.06
	T	−0.36	(−0.71, −0.01)	0.06
	P	−0.23	(−0.44, −0.02)	0.06
Predictability	M	−0.08	(−0.22, 0.06)	0.29
	T	−0.16	(−0.44, 0.12)	0.28
	P	−0.08	(−0.26, 0.10)	0.42

Estimates from regression analysis weighted by the number of subjects at the workplace.
*Regression coefficients show effect of a 10-point increase on the psychosocial scales.
M indicates municipal care; T, technical services; P, pharmaceutical company.

and high psychological demands have also been identified as contributors, however, findings were not as consistent. The impact of psychosocial factors at the workplace level on absence has only been analyzed in few studies. In the Whitehall II study, psychosocial work conditions assessed by personnel managers predicted absence just like self-reported variables, although the two measures were not highly correlated.[6] It is an ongoing discussion, whether external assessment of stressors is to be preferred to self-reported assessments by employees.

In the psychosocial literature three different methods for measuring work environment factors have been used: The individual assessment, the average score for jobs or workplaces, and independent methods such as ratings by external observers. The individual method is often called "subjective" whereas the expert ratings have been called "objective." This terminology is unfortunate because the characteristics of the methods and the phenomena being assessed are confused. All three methods have advantages and drawbacks.[22,23] In the present study, we compared the individual assessments and workplace averages. The individual assessments are important for understanding individual differences in absence rates and in particular for understanding differences between individuals within the same workplace. The workplace scores, on the other hand, are important for understanding differences in workplace averages in absence rates. A basic condition for using this method is, of course, that sufficient exposure contrasts exist between the workplaces being compared.

As mentioned in the introduction, we analyzed the effects of individual level psychosocial work environment factors on sickness absence in the IPAW population in a previous article.[18] Comparing the findings from this previous work with the results from the present study reveals that low decision authority is a predictor for sickness absence regardless of whether it is assessed on the individual level or the workplace. Low skill discretion predicted sickness absence when measured at the workplace level but not on the

TABLE 3
Effect of Workplace Levels of Psychosocial Factors on Individual Level Sickness Absence

		Model 1			Model 2		
	Organization	RR*	95% CI	*P* Value	RR*	95% CI	*P* Value
Psychological demands	M	1.17	(0.97, 1.41)	0.13	1.22	(1.00, 1.48)	0.08
	T	0.73	(0.54, 0.99)	0.06	0.82	(0.59, 1.12)	0.23
	P	1.05	(0.66, 1.68)	0.83	1.09	(0.68, 1.74)	0.73
Skill discretion	M	1.13	(0.87, 1.48)	0.37	1.10	(0.82, 1.48)	0.52
	T	0.82	(0.65, 1.05)	0.15	0.81	(0.65, 1.00)	0.09
	P	0.77	(0.62, 0.94)	0.04	0.74	(0.62, 0.88)	0.02
Decision auth.	M	0.72	(0.53, 0.99)	0.06	0.71	(0.51, 1.00)	0.06
	T	0.66	(0.51, 0.87)	0.00	0.66	(0.51, 0.86)	0.00
	P	0.77	(0.60, 1.00)	0.08	0.77	(0.59, 1.00)	0.08
Predictability	M	0.96	(0.80, 1.15)	0.66	0.94	(0.78, 1.14)	0.54
	T	0.90	(0.71, 1.14)	0.39	0.93	(0.74, 1.18)	0.58
	P	1.00	(0.77, 1.30)	1.00	1.03	(0.79, 1.33)	0.84

*Rate Ratios (RR) show effect of a 10-point increase of the workplace mean.
Model 1 is controlled for control for age, gender, family status, intervention group assignment,
Model 2 is further controlled for smoking, alcohol consumption and BMI.
M indicates municipal care; T, technical services; P, pharmaceutical company.

individual level. Individual levels of predictability, on the other hand, showed a strong and highly significant association with absence in men, but workplace levels of predictability were not significant predictors of absence. This result underlines the importance of studying both the individual and the workplace level.

Absence on the individual level was the outcome of interest in this study, but the logarithm of absence rates at the workplace level also were used to illustrate the workplace level effects. Results varied somewhat across the three organizations, with very little difference between the workplaces in municipal care. These results are partly in accordance with expectations, as work tasks in institutions caring for elderly people or mentally handicapped are much more similar than the tasks in the diverse range of workplaces in the two other organizations. On the other hand, some psychosocial variables, like decision authority and skill discretion, may be more associated with leadership and culture in the workplace than with tasks. In general, findings will depend on the context. For example, Verhaeghe et al[24] found an effect of social support in health care workers but not in controls from other service jobs. This might also explain, why different studies do not find identical results.

IPAW has some strong features contributing to the credibility of the results. The cohort includes a large number of workers of both genders and different types of job in both private and public sectors. Many variables of interest are measured and analyzed, including psychosocial and physical work environment, health behaviors, and demographic variables. The measures are theory based, well validated, and most of them are comparable with previous results from other studies.[12] The study is prospective, which rules out reverse causality, and based on registered absence data that rules out recall bias.

The study also has some limitations. We did not have information on other potentially important psychosocial work environment factors, such as management style, workplace absence cultures, effort reward imbalance, or emotional demands in work. The study population was predominantly female (68%) and consisted mainly of unskilled, semiskilled, or skilled workers (63%). Furthermore, it was geographically restricted to the Copenhagen area. In that sense, the generalizability may be limited. We also do not know to what extent the work environment factors have changed during the course of the follow-up. Therefore, we probably have some nondifferential misclassification of the predictor variable, which would lead to an underestimation of the associations.

The results of the present study add to the evidence that a poor psychosocial working environment influence absence also when analyzed on the workplace level. The results also suggest that interventions to improve workplace levels of psychosocial factors might lower absence rates: Together workplace levels of skill discretion and decision authority explained 44% to 52% of the variation in absence between the 52 workplaces when controlling for relevant confounders. Although workplace means of decision authority and skill discretion could maybe be improved by individual stress-management strategies, it seems more obvious that the proportion of absence explained by workplace means should be reduced by primary preventive measures improving the work environment at the workplace.

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