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This is an accepted version of a paper published in *Sleep Medicine*. This paper has been peer-reviewed but does not include the final publisher proof-corrections or journal pagination.

Citation for the published paper:

Åkerstedt, T., Nordin, M., Alfredsson, L., Westerholm, P., Kecklund, G. (2012)
"Predicting changes in sleep complaints from baseline values and changes in work demands, work control, and work preoccupation - The WOLF-project"
Sleep Medicine, 13(1): 73-80

URL: <http://dx.doi.org/10.1016/j.sleep.2011.04.015>

Access to the published version may require subscription.

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<http://diva-portal.org>

Predicting changes in sleep complaints from baseline values and changes in work demands, work control and work preoccupation – the WOLF-project

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Acknowledgement: This work was supported by the Swedish Council for Working Life and Social Research, the Insurance Company Alecta AB, and Stockholm Stress Center University of Stockholm and Karolinska institutet). Torbjörn Åkerstedt has had speaking assignments with Apoteket AB, Sanofi-Aventis, and a consulted for Johnson and Johnson. None of the co-authors have declared any conflicts of interest.

Abstract

Study Objective: Stress as a cause of disturbed sleep is often taken for granted, but the longitudinal evidence is limited. The aim was to study new cases of poor sleep as a function of changes in reported work demands, work control and work preoccupation.

Design: Longitudinal study of change with measures twice with a 5-year interval during a period when the prevalence of impaired sleep was increasing in Sweden

Setting: Sample of companies in northern Sweden (Norrland).

Participants: 3637 individuals from the “WOLF Norrland” longitudinal cohort, collected through company health services.

Measurement and Results: During the measurement period 16 % new cases of impaired sleep occurred. Logistic regressions adjusted for demographics, work environment factors and disturbed sleep at T1 showed a significant increase in new cases for high work demands and high work preoccupation (OR=1.37; CI=1.09-1.72 and OR=1.80; CI=1.42-2.28, respectively). The analysis of change in the predictors showed effects of a change from low to high work demands (OR = 1.39; CI=1.00-1.95) on new cases of impaired sleep. Consistent high work demands (high at both points) showed a similar increase (OR=1.49; CI=1.06-2.11) but no effect was seen for reduced demands. Change in work preoccupation yielded stronger effects with OR=2.47 (1.78-2.47) for increased work preoccupation, OR=3.79 (2.70-5.31) for consistent high work preoccupation. Also a reduction in work preoccupation was associated with a reduction in new cases of disturbed sleep. Control at work was not related to sleep.

Conclusions: It was concluded that self-reported work preoccupation predicts subsequent impairment of sleep and that increased preoccupation is associated with new cases of impaired sleep. Similar, but weaker results were obtained for Work demands.

Key words: Sleep, demand, control, preoccupation, stress, commitment, longitudinal, change

The prevalence of disturbed sleep has approximately doubled in Sweden between 1993 and 2003 according to cross-sectional surveys ^{1, 2}. The reason for this increase is not known but increased levels of stress in society is one of the possible candidates. Stress causes increased physiological and psychological activation as a response to increased environmental demands ^{3, 4} and this activation is assumed to interfere with sleep. However, there is relatively little empirical support for the latter assumption. Still, stress is considered the primary cause of persistent psychophysiological (or primary) insomnia ⁵. In the new International Classification of Sleep Disorders (ICSD2) ⁶ “adjustment insomnia” represents the effects of acute stress whereas “primary insomnia” represents the long-term consequences of mainly adjustment insomnia.

The notion of the stress-sleep connection is mainly based on clinical impressions and cross-sectional epidemiological studies have shown a strong link between stress and sleep ⁷⁻¹⁰. Most, but not all, are focused on work stress, in particular. Of these, Kalimo et al ¹¹ used the Helsinki heart study and found that high work strain, defined as high demands and low influence at work according to the “demand/control” index ¹² were associated with a 30% prevalence of disturbed sleep vs 5% in the low strain group (low demands + high influence at work). Åkerstedt et al. ¹³ used the same demand/control index but looked at the two dimensions separately. It was found that only the demand index had a significant relation to disturbed sleep and that the strongest item of the demand index was “having to exert a lot of effort at work” - not simply “having too much to do”, for example. It was also found that when the item "not being able to stop thinking about work in the evening" was added to the regression this variable took over part of the role

of work demands as a predictor. This suggested that “immersion” or work over-commitment may be an important factor.

The item “not being able to stop thinking about work” used in the study by Åkerstedt et al.¹³ is part of the work over-commitment (WOC) index, a part of the effort/reward index developed by Siegrist et al.¹⁴. The work over-commitment index includes five items such as “not being able to stop thinking about work” and “start thinking of work immediately when I wake up”. In a cross sectional study Fahlén et al.¹⁵ found a fourfold increase of risk of reporting disturbed sleep for high levels of over-commitment. These observations suggest that it may not be the perception of work demands *per se* that are important, but rather the preoccupation with worries about them. Work over-commitment is normally seen as a *trait*¹⁴, but it seems obvious that some of the items reflecting “work preoccupation” may to also be interpreted a *state* that may vary depending on work load (not being able to stop thinking about work in the evening, for example. Such a state might reflect the response to, for example, increased demands.

The first *prospective* study of work stress and sleep seems to be the one by Ribet et al.⁹ who studied more than 21,000 subjects in France, using a sleep disturbance index. Shift work, a long working week, exposure to vibrations, and “having to hurry” appeared to be the main risk factors, controlling for age and gender. Another prospective self-report study showed a relation between “negative psychosocial work conditions” and insomnia, with an Odds Ratio across five years of 2.15¹⁶. Jansson et al.¹⁷ controlled for initial insomnia in a similar design, and found that high work demands at the outset predicted impaired sleep one year later. Virtanen et al.¹⁸ found in a prospective study of overtime work that a considerable part of the overtime effect was due to high work demands.

De Lange et al ¹⁹ recently showed that a *change* from low to high strain (high influence / low work demands to low influence / high work demands) across two measurements resulted in increased sleep problems and fatigue, as did high strain at both points in time. While relatively small (<100 individuals in most categories), the results from the De Lange et al study seem robust. However, the study only controlled for age and gender and it is conceivable that also socio-economic status, physical work load and other factors may be associated with a change in work demands. Furthermore, adjustment for such factors should probably be based on a *change* between the two points in time, not merely the status at T1. A change in marriage status may be another confounder; unmarried individuals show more sleep complaints ¹³. One might also wonder whether the strain model (the combination of high/low demands and high/low control at work) may be ideal, since the latter does not seem to have a relation to impaired sleep ¹³. Possibly, an interesting approach would be to use the two dimensions as separate predictors. In the latter study it was also concluded that “work commitment” (not being able to stop thinking about work in the evening, and similar items) had a considerably stronger link to impaired sleep than work demands ¹³.

The purpose of the present study was to investigate the effect of work demands, work control, and as well as work preoccupation (WP), on subsequent new-onset sleep disturbances. For this purpose the so-called WOLF-Norrland cohort was used. It spans the period 1996-2003, which coincides with the steep increase in sleep disturbances observed in cross-sectional survey studies ^{1,2}. The approach was to first predict new cases of disturbed sleep from exposure at T1, while controlling for confounders at T1 and T2. However, since high stress/control at T1 is likely to include participants who maintain a

high stress level at T2, as well as participants that have reduced their stress level by T2, the approach was to also study these two groups, as well as the two groups with low stress at T1, that is, those that remain on a low stress level at T2, but also the group that has changed to high stress by T2. This separation of change from static levels should provide more detailed information about the effects of stress/control on sleep, even if the change aspect is vulnerable to problems of reverse causation.

Methods

Design and participants

The present study uses the WOLF-Norrland database. This is a dynamic cohort study aiming at assessing the effects of work organization and psychosocial variables on health. All Occupational Health Service units (OHS) in two provinces in northern Sweden (Västernorrland and Jämtland) were invited to participate between the years 1996 and 1998 (T1). The OHS:s offered a health organization to all the employees. Fifteen organizations agreed to participate. To standardize the procedures of the examination, the OHS personnel were trained in standardized measurement procedures. The participating organizations were then re-invited in the follow-up study (T2, collected between 2000 and 2003). Up to three reminders were sent, unless the individual declined to participate. Time to follow-up was on average 60 months (five years) with a range of 11 months. The study was approved by the ethical committee of Umeå University.

The original population at T1 constituted 5092 individuals, of which 4715 responded (93%) (Figure 1). The follow-up response rate at T2 was 71% (of the population at T1),

leaving 3637 participants in the database. An analysis of the drop-outs showed that a significantly higher proportion of men (1,173; 23%) than women (252; 15%) were lost to follow-up ($\chi^2 = 56.11$, $df = 1$, $p < .001$). Among the women who dropped out a larger proportion reported disturbed sleep at T1 (55; 36%) than among women who remained in the study (131; 26%; $\chi^2 = 5.32$, $df = 1$; $p < .05$). The purpose of the longitudinal study was to study a working population, thus everyone included at T1 were working and without any disabling diseases. For the purpose of the present study, those who reported that they were not working at T2 due to e.g. sick leave, retirement, parental leave or studies were excluded. Thus, the database used for the purposes of this study included 3077 persons, which constituted 60% of those approached at T1 or 65% of the responders at T1.

Questionnaire

Demands at work was estimated by the demand-control model postulated by Karasek and Theorell (1990). A factor analysis confirmed the demand index and the questions were summed and divided into quartiles. Based on the lower quartile cut-off at T1, the cut-off was set between 11 and 12 (the scale ranged between 5 and 20), and those in the lower quartile were defined as perceiving high demands at work and contrasted with the rest. Low scores mean that the respondents affirmed the questions about demand. Cronbach's alphas were 0.71 at T1 and 0.69 at T2.

Control at work was assessed with the Swedish version of the Job Strain Questionnaire (JSQ; Karasek & Theorell, 1990). The control index was treated as one dimension. Based on quartiles at T1, the index was dichotomized between scale steps 13 and 14 (the highest quartile). The maximum score is 24 and a high score indicates that the participants

responded negatively to having control at work. Cronbach's alpha was 0.31 at both T1 and T2. Due to the low Cronbach's alpha coefficient the question on repetitive work, which lowered the Cronbach's alpha coefficient substantially (from 0.61 to 0.31), was excluded. The analyses were thereafter run with the altered control variable. No different results were obtained compared to the original analyses. Therefore, results from the original analyses, based on the traditional index construction, are presented here.

Work Preoccupation (WP) was defined by three of the questions of the work commitment scale of Siegrist et al ²⁰. "As soon as I get up in the morning I start thinking about work problems", "When I get home, I can easily relax and 'switch off' work", "Work rarely lets me go, it is still on my mind when I go to bed". The Chronbach coefficient alpha for these three questions varied between 0.77 and 0.79. Three other questions from the work commitment scale were excluded since they did not fit well under the heading work preoccupation. The questions were summed and dichotomized into quartiles. The lowest quartile (the cut-off was set between 11 and 12 on a scale from 6 to 20) was defined as perceiving a high preoccupation with work.

The Karolinska Sleep Questionnaire (KSQ) was used for assessing disturbed sleep. KSQ contains 14 questions about sleep disturbances and assesses three dimensions of sleep; sleep quality (disturbed sleep), fatigue, and impaired awakening ²¹. The dimension assessing sleep quality in the KSQ was used as the outcome variable in the present study. The items included are: difficulties falling asleep, restless sleep, repeated awakenings, premature awakening and the response ranges from "never" to "most days of the week" (with values from 1-5 assigned). A factor analysis with varimax rotation confirmed this

dimension and internal consistency was high, with Cronbach's alphas of 0.78 at T1 and 0.82 at T2. Each question in the disturbed sleep index was dichotomized so that the response alternatives "a few times per week" and "every night" were identified as disturbed sleep and coded with the number 1. Thereafter, the four questions included in the sleep quality index were summed and those scoring one to four (i.e. had *any* of the symptoms included in the sleep quality index a "few times per week" or "every night") were identified as having disturbed sleep. The criterion was set to be similar to the research criteria for insomnia²². According to these criteria 598 persons (19%) were identified as having impaired sleep at T1. The corresponding figure for T2 was 878 (29%).

For the analysis of change, the variables were combined over time, which created four categories. The new variables were labeled "development over time" and included the combinations of positive responses at both T1 and T2 (good-good/high-high), negative response at T1 and positive response at T2 (decrease/improvement), positive response at T1 and negative response at T2 (increase/impairment), and negative responses at both T1 and T2 (poor-poor/low-low; see Table 2). The outcome variable, new cases of disturbed sleep, was identified analogously with identifying impairment in the predictor variables.

Confounding variables

Several potential confounding factors were considered in the analyses. These are presented in Table 1. Among them were *gender* and *age*. The difference in age was calculated by subtracting age at T2 from age at T1.

Education was assessed by the question “Which one of the following schools/educations have you attended?” The response “alternative university education” was contrasted with all other alternatives.

Socioeconomic group - SEG (blue collar vs. white collar) was classified using the Nordic Occupational Classification Index ²³. This is a register of systematically categorized domains, families and individual occupations by codes and with descriptions. The base is the international occupational classification, ISCO. NYK is hierarchical and builds upon work oriented characteristics without regard to education or position.

Shift work was measured with the question “Do you work shifts?” with the response alternatives “no”, contrasted with “yes” (including any of the alternatives: 2-shift, continuous 3-shift, irregular work schedule without night shift, irregular work schedule with night shifts, permanent night work, other type of shift work).

Heavy physical work was assessed with the question “How much effort does your work require?” The response scale, ranged from none (1) to extreme (14). Heavy work was defined by dichotomizing the scale between scale steps 7 and 8 at both T1 and T2.

Physical activity was assessed by the question “How much do you exercise?”. The response alternative “regularly” was contrasted against, “never”, “very little”, and “now and then” both at T1 and T2.

For *marital status* the response alternatives were “married/cohabiting”, “single”, “divorced”, and “widow/widower”. The first alternative was contrasted with the other response alternatives. “*Having had a child* within 12 months prior to T1” was also included among the confounders, with “yes” contrasted with “no”.

Variables measuring development across the five years of follow-up were created in all cases where data from both T1 and T2 were obtainable. Thus, development variables were created for control at work, shift work, work status, heavy work, physical activity,

marital status, and education by combining the dichotomized variables presented above.

These variables were created to identify changes (improvement (i.e. loss of cases) and impairment (i.e. new cases) and status quo (constant poor or good) in the responses.

These variables are presented in Table 2.

Statistical methods

The data was analyzed using a multiple logistic regression analysis. New cases of impaired sleep were used as the outcome variable and demands at work, control at work, and work preoccupation at T1 were entered as predictor variables, as was impaired sleep at T1. Confounding variables at T2 were also entered into the analysis. For the first analysis low demands at T1 was entered as reference category. Work preoccupation and control were handled in the same way, using “low” and “high”, respectively, as references.

In the analysis of *change*, the change (and no change) in demands at work, control at work, and work preoccupation were entered as predictor variables. At the same time, change in the confounding variables was entered. For the analysis of change the category “consistent low” was used as reference. In addition, a separate analysis was carried out for “decreased” work demands, using the “consistent high” work demand category as reference, since a true effect of decrease in demands would approach an odds ratio of 1 when “consistent low” is used as reference. Work preoccupation and control were handled in the same way, using “consistent low” and “consistent high”, respectively, as references.

Four models were created for each combination of exposure and outcome variable. The first model contains the unadjusted association between predictor and outcome variables. In the second model, the potential confounding variables were included. These included sex and age, plus development in control, shift work, heavy work, socio-economic group, marital status, physical activity, and education, as well as having had a child within 12 months prior to T1, and age. These two models were considered to be the major ones. Two more models were used. Model 3 contained model 2 plus work demands and work preoccupation. Model 4 added work control to model 3.

Results

Prevalence and changes

Over the five years of follow-up, the sample distribution shifted somewhat with regards to the included background variables (Table 1).

Table 1 about here

Table 2 shows the percentage of individuals that changed category across time and that remained in the same category across time. Thus, 16% showed impaired sleep and 7.1 % improved sleep, while work preoccupation showed a change of 13.3% from low to high and of 7.2% in the other direction, 14% changed from low to high work demands and 12% in the other direction, 14% changed from low to high control and 10%, in the other direction, 4% changed work status from blue to white collar and 16% changed in the other direction. Other changes were rather similar in terms of direction of change.

Development in work demands and work preoccupation showed a correlation of $r=0.41$ ($p<0.01$). Development in work demands and work control showed a correlation of $r=-0.16$ ($p<0.001$). The corresponding figure for development in work preoccupation and development in control was $r=-0.23$ ($p<0.001$).

Table 2 about here

Predicting new cases of impaired sleep

The results of the first logistic regression (Table 3), predicting new cases at T2 from exposure at T1, shows that work demands at T1 predicted new cases of disturbed sleep at T2 without adjustment for confounders and that adjustment for confounders caused only minor changes. The last model, with also the other predictors included, showed a stronger reduction of the OR, but still significant. *Work preoccupation* showed the same pattern but clearer effects. Control at work showed a significant effect without adjustment, but lost this effect in the other models.

The results from the analysis of changes (and consistent conditions) in exposure show that *consistent high demands* at work was associated with increased sleep problems in all four models. In the third model, in which work preoccupation was added, the odds ratio fell somewhat, while work preoccupation showed a high odds ratio.

Increased demands was also associated with a significantly increased Odds Ratio for all models, but again with a reduction for model 3, and a decrease to non-significance in model 4, in which work control was entered into the model.

A decrease in work demands had a non-significant relation to new cases of poor sleep in all four models, except for model 2.

Changes in *work preoccupation* showed highly significant odds ratios for all predictors across all models. New cases of impaired sleep increased with increased or consistently high work preoccupation, and showed a decrease of new cases with decreasing work preoccupation. The development in *work control* did not show any association with new cases of impaired sleep.

Table 4 about here

Finally, the relation between work demands at T1 predicted work preoccupation at T2 (OR=3.17; 2.67-3.76). Adjusting for preoccupation at T1 the values became OR=2.08 (1.71-2.52). An increase in demands yielded an increase in new cases of work preoccupation (OR=2.41; 1.77-3.29); consistent high demands yielded OR=2.93 (2.03-4.22).

Discussion

The increase in prevalence (and new cases) of impaired sleep across time agrees with observations in prior cross-sectional survey studies^{1,2}. One major finding in the present study, that may help explain that increase in incidence, was that high work demands at T1 was related to new cases of disturbed sleep, while controlling for a number of confounders as well as for the other predictors.

The result above is supported by the additional finding that *increased* work demands were linked to the occurrence of new cases of disturbed sleep. High work demands have previously been related to more sleep complaints^{9, 16, 17}, but the present study also linked the *changes* in predictors and dependent variables, while controlling for changes in control at work. Moreover, the results are in line with a number of cross-sectional studies^{7, 8, 10, 11, 13}. Model 4 only showed a trend, but the major models were 1 and 2 (unadjusted and adjusted for change in demographic and background variables) while models 3 and 4 were exploratory. The latter involved adjustment also for control at work. Since the analyses were controlled for several confounders we interpret the overall results as indicating that high and increased demands at work predict future occurrence of disturbed sleep.

The other major finding was that increased work preoccupation at T1, with control for confounders and disturbed sleep at T1, predicted new cases of impaired sleep. The effect was larger than that for increased work demands. As with work demands, the *increase* in work preoccupation was related to an increase in new cases of disturbed sleep across time. The results are in line with cross-sectional studies of work demands and sleep^{10, 24}. The strong effect of work preoccupation in the present study adds a dimension to the results of the effects of increased work demands. It suggests that a strong emotional response to demands - a preoccupation with thoughts of work – has a stronger relation to sleep than merely changes in demands. It is, however, noteworthy that both predictors remained significant when they were entered together (in model 3), even if the odds ratios were somewhat reduced. This indicates that the two still are partly independent predictors of changes in sleep complaints.

The effect of work preoccupation in the present and other studies ^{10, 13, 15} is in line with the role of rumination in disturbed sleep. Cropley et al ²⁵ coupled the relation between strain and poor sleep in teachers to rumination, which is seen as a major cause of disturbed sleep ²⁶. Hall et al. ²⁷ have demonstrated in a cross-sectional study that intrusive thoughts at bedtime are related to increased alpha and beta power in the subsequent sleep EEG. Jansson et al ²⁸ found a causal role of “worries” for sleep disturbances in a one-year longitudinal study. Similarly, increased cognitive arousal at bedtime is related to increased sleep latency ^{29, 30}.

States similar to that of rumination, such as worrying and tension, have also been found to cause negative changes in sleep architecture. Thus, worrying and tension before sleep, due to the need to awaken early for work, showed reduced amounts of sleep stages 3+4 (Slow Wave Sleep – SWS) ^{31, 32}. The same result was seen in ship’s machine officers during a night on call, without actually being called ³³. In another longitudinal study, an evening with increased levels of stress/worries at bedtime was characterized by more sleep fragmentation and a longer delay to the start of SWS ³⁴.

The results in the present study also showed that individuals with consistently high demands or work preoccupation have an increased risk of new cases of sleep impairment across time. Again, the effect was stronger for work preoccupation. The results suggest that long-term exposure to work stress results in an increased level of sleep disturbances, which is one of the basic assumptions of the diagnosis of psychophysiological insomnia ⁶.

It was also observed that the reduction of work demands was not significantly related to a decrease in the risk of new cases of impaired sleep in the main analysis. However, the reduction in work preoccupation was significantly associated with a reduced occurrence of new cases of disturbed sleep. The results at least suggest that reduced work preoccupation and a reduction in new cases of impaired sleep covary.

The change in control at work did not show any relation to new cases of impaired sleep. This is similar to what was found in a previous cross sectional study ²⁴ and suggests a lack of relation between work control and sleep.

It should be pointed out that the analysis of simultaneous change in predictors and outcome variables opens for problems with reverse causation. Increases in disturbed sleep could possibly affect perceptions of work demands and work over-commitment.

However, the first analysis, predicting new cases of disturbed sleep at T2 from high demands at T1, argues for the two predictors being associated with incidence of disturbed sleep. The second analysis (of change) sheds further light on this effect by showing that extending high demands or work preoccupation in time is associated with new cases of disturbed sleep, and that increases and decreases in WOC, and partly for work demands, are associated with corresponding changes in new cases of insomnia.

Another limitation may be “subjectivity bias”, that is, a dispositional tendency of an individual to report both psychosocial adversity and more health symptoms. This phenomenon is probably present in most studies of psychosocial factors and health, and may affect part of the associations between such variables. On the other hand, one would expect a certain amount of consistency across predictors. In the present case “control at

work” did not show any significant relation to disturbed sleep, which would have been expected had subjectivity bias been strong.

Even if the results seem rather clear-cut, other factors may have been involved, even if changes in a number of potential confounders were adjusted for. In particular, stress due to family problems or economical situation could have been involved. Unemployment was controlled for, however, since only persons with employment were included. This question will have to await further studies. The presence of disease at T1 (or the change across time) was not evaluated in the present study and there is a possibility that part of the relation between the stress variables and sleep might have been influenced by this lack of control. Depression may be such a variable and could, for example both the perception of work demands and work preoccupation. This will have to be resolved in future studies. However, the longitudinal link between work demands / work preoccupation and impaired sleep still appears strong as does the link between work demands and work preoccupation.

The relatively long time for follow-up (five years) does not permit a closer analysis of short-term changes within this period or the duration of a change in exposure. This does not necessarily invalidate the conclusions, but indicates that a certain caution in generalization is warranted.

In conclusion, the present study indicates that work demands and, in particular, preoccupation, is associated with changes in the occurrence of impaired sleep.

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Table 1. Description of outcome, predictor, and confounding variables at T1 and T2, as well as cases of insomnia, by category of predictor and confounding variables.

	T1: N, %, M±sd		T1: Cases of impaired sleep	T2: N, %, M±sd		T2: Cases of impaired sleep	New cases of impaired sleep
	n/%	M±sd	n/%	n/%	M±sd	n/%	n/%
Insomnia	598/20	8.7±2.9		878/29	9.7±3.1		504/21
Demands		12.8±2.5		2107/69	12.6±2.3		
High	882/29		209/24	928/31		325/36	190/27
Low	2146/70		378/19	2066/67		530/26	305/19
WP		9.95±2.13			9.65±2.26		
High	683/22		183/31	838/28		350/40	140/40
Low	2371/78		489/20	2180/72		466/23	56/26
Control		16.4±3.1			12.4±2.7		
High	1925/63		354/19	2029/66		554/28	330/21
Low	1131/37		240/22	987/33		306/32	166/22
Shift work							
No	1992/65		377/19	2011/65		548/28	321/21
Yes	1081/35		221/21	1027/34		320/32	176/22
Heavy work							
Yes	472/15		104/22	502/16		175/36	91/25
No	2592/84		491/19	2529/82		693/28	405/20
SEG							
Blue collar	1835/61		363/20	2212/74		195/33	361/25
White collar	1179/38		228/20	802/26		681/29	136/21
Marital Status							
Married	2402/78		468/20	2441/79		195/33	391/21
Unmarried	672/22		130/20	617/20		681/29	111/24
Childbearing T1							
Yes	121/4		30/25				
No	2923/95		565/20				
Physical activity							
Yes	1003/33		413/20	959/32		67/30	168/22
No	2069/67		184/19	2072/67		265/28	331/21
University education							
Yes	463/15		525/21	453/15		731/30	81/22
No	2603/85		73/16	2511/82		109/24	406/21
Sex							
Men	2562/83		467/19	2562/83		702/28	399/20
Women	515/17		131/26	515/17		176/35	105/29
Age *		42.7±8.9			47.5±8.9		
Young	1458/47		283/20	951/31		240/26	151/20
Old	1618/53		314/20	2125/69		638/31	353/22

*Young and old groups are identified by splitting the file on the median age (42 years) at T1. The T1 median age is used for identifying cases with insomnia both at T1 and T2. SEG= Socioeconomic group.
WP=work preoccupation

Table 2. Development in the outcome, predictor, and confounding variables over the 5 year follow-up period, as well as cases of insomnia at T2 by change in predictor and confounding variables.

			New cases of insomnia at T2	
	n	%	n	%
Sleep				
Good at T1 and T2 (good-good)	1,870	61		
Poor at T1 and good at T2 (improved)	217	7.1		
Good at T1 and poor at T2 (impaired)	504	16		
Poor at T1 and T2 (poor-poor)	357	12		
Demand at work				
Low at T1 and T2 (low-low)	1,677	55	414	25
High at T1 and low at T2 (decreased)	363	12	110	32
Low at T1 and high at T2 (increased)	417	14	136	34
High at T1 and T2 (high-high)	491	16	184	38
Work preoccupation				
Low at T1 and T2 (low-low)	1,950	41	335	56
High at T1 and low at T2 (decreased)	216	7.2	51	8.5
Low at T1 and high at T2 (increased)	380	13	72	12
High at T1 and T2 (high-high)	454	15	130	22
Control at work				
High at T1 and T2 (high-high)	1,572	51	420	27
Low at T1 and high at T2 (increased)	444	14	130	31
High at T1 and low at T2 (decreased)	318	10	94	30
Low at T1 and T2 (low-low)	662	22	207	32
Shift work				
Not shift at T1 and T2	1,866	62	511	28
Shift at T1 but not at T2 (exit shift)	145	4.8	37	26
Not shift at T1 but at T2 (entry shift)	112	3.7	24	26
Shift at both T1 and T2	913	30	296	34
Heavy work				
Light at T1 and T2	2,304	75	623	28
Heavy at T1 but not T2 (decreased)	213	6.9	67	32
Light at T1 but not at T2 (Increased)	250	8.1	82	35
Heavy both at T1 and T2	252	8.2	93	38
Socio-economic group (SEG)				
White collar at T1 and T2	666	22	186	29
White collar at T1 and blue collar at T2	502	16	24	20
Blue collar at T1 and white collar at T2	123	4	154	31
Blue collar at T1 and T2	1,701	55	497	30
Physical activity				
Active at both T1 and T2	618	20	164	27
Active at T1 but inactive at T2 (reduced)	341	11	101	31
Inactive at T1 but active at T2 (increased)	373	12	115	31
Inactive at both T1 and T2	1,696	56	490	30
Marital status				
Married at T1 and T2	2,238	73	636	29

Unmarried at T1 and married at T2 (entry)	201	6.5	44	22
Married at T1 and unmarried at T2 (exit)	151	4.9	62	41
Unmarried at T1 and T2	465	15	133	30
University education				
University at T1 and T2	396	13	93	24
Not university at T1 but at T2 (entry)	57	1.9	16	28
Not university at T1 and T2	2,446	83	714	29

Table 3 Multivariate logistic regression predicting new cases of disturbed sleep from high work demands, high work preoccupation (WP) and low control at work at T1.

Predictor	Unadjusted OR/CI	Model 1 OR/CI	Model 2 OR/CI	Model 3 OR/CI	Model 4 OR/CI	Model 5 OR; CI
Work demands						
Low	1	1	1	1	1	1
High	1.50 1.27-1.78	1.38 1.15-1.68	1.51 1.24-1.85	1.49 1.22-1.83	1.49 1.21-1.84	1.37 1.09-1.72
WP						
Low	1	1	1	1	1	1
High	1.58 1.35-1.85	1.43 1.21-1.70	1.98 1.59-2.47	1.89 1.52-2.35	1.89 1.50-2.38	1.80 1.42-2.28
Control at work						
High	1	1	1	1	1	1
Low	1.21 1.03-1.43	1.14 0.96-1.36	1.03 0.84-1.24	0.99 0.81-1.20	0.97 0.79-1.19	0.99 0.80-1.23

Note: Bold = significant effect at $p < .05$ or higher.

Model 1: adjusted for sleep disturbance at T1; Model 2: adjusted for all T1 covariates;

Model 3: adjusted for all T2 covariates; Model 4: adjusted for all T1 and T2 covariates;

Model 5: model 4 plus adjusted for the two other predictors.

Table 4. Results from multivariate logistic regression analyses (Odds Ratios (OR) and 95% Confidence Intervals (CI) for development in work demands, work preoccupation (WP) and work control, predicting new cases of disturbed sleep between T1 and T2.

Predictor	Model 1 OR CI	Model 2 OR CI	Model 3 OR CI	Model 4 OR CI
Consistent low demands	1	1	1	1
Increased demands	1.56 1.17-2.07	1.64 1.20-2.23	1.42 1.02-1.99	1.39 1.00-1.95
Consistent high demands	1.87 1.43-2.44	1.98 1.46-2.68	1.50 1.06-2.11	1.49 1.06-2.11
Decreased demands	1.36 0.99-1.87	1.46 1.03-2.06	1.21 0.83-1.77	1.24 0.85-1.80
Consistent low WP	1	1	1	1
Increased WP	1.89 1.58-2.26	2.64 1.92-3.63	2.47 1.78-3.43	2.47 1.78-3.43
Consistent high WP	3.40 2.33-4.95	4.18 3.03-5.77	3.79 2.70-5.31	3.79 2.70-5.31
Decreased WP	0.71 0.51-1.00	0.63 0.44-0.92	0.65 0.45-0.95	0.65 0.45-0.95
Consistent high control	1	1	1	1
Increased control	1.03 0.73-1.44	0.95 0.65-1.25	1.14 0.78-1.49	1.22 0.82-1.82
Consistent low control	1.12 0.87-1.44	0.91 0.68-1.22	1.08 0.78-1.49	1.09 0.79-1.51
Decreased control	1.29 0.92-1.81	0.96 0.70-1.33	1.02 0.72-1.46	0.98 0.68-1.41

Note. Model 1 = no adjustment; Model 2 = adjustment for development in shift work, heavy work, work status, marital status, physical activity, and education as well as had a child, sex and age difference; Model 3 = Model 2 + development in work preoccupation and in work demands. Model 4 = Model 3 + development in control.

Figure 1